ILLUMINATING ENGINEER

XXVI | Jan. 1933 | Price 9d

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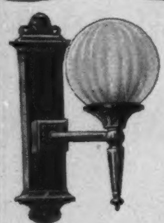

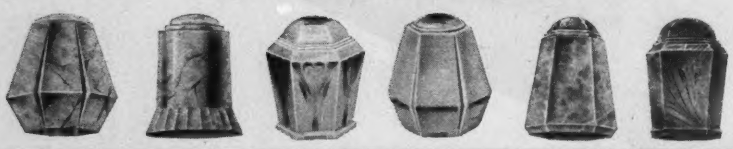

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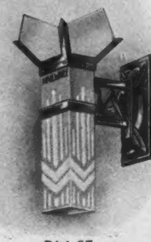

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THE ILLUMINATING ENGINEER

THE JOURNAL OF GOOD LIGHTING

LIGHT LAMPS FITTINGS AND ILLUMINATION

OIL GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.

OFFICIAL JOURNAL of
The Illuminating Engineering Society
(Founded in London, 1909, Incorporated 1930)
and of
THE ASSOCIATION OF PUBLIC LIGHTING ENGINEERS
(Founded 1923; Incorporated 1928)

Vol. XXVI — January, 1933 — Price NINEPENCE
Subscription 10/6 per annum, post free.

Edited by
J. STEWART DOW

EDITORIAL AND PUBLISHING OFFICES:
32 VICTORIA STREET, LONDON, S.W.1.
Tel. No.: Victoria 5215

Football by Artificial Light

RECENT events, such as the floodlighted game of Association football on the Arsenal practice ground, on December 1st, and the more ambitious Rugby match staged at the White City Stadium, on December 14th, have served to call attention to the increasing demand for facilities for playing games on winter evenings by artificial light. The artificial lighting of greyhound racing tracks is familiar, and there is a prospect of another development—the artificial lighting of courses for pony racing. From time to time also we hear of golf being played under similar conditions. The latest experiment, stated to have been successful, has been the floodlighting (with " 50,000,000 candle-power ") of a golf course at San Francisco.

We have little doubt that, in spite of the opposition that such innovations invariably excite, the movement will progress. We are, however, less certain that complete and final success will be achieved by present methods. These seem to involve attempts to illuminate large outdoor areas, under conditions resembling either those met with in street lighting or those associated with outdoor spectacles, such as the military tatoo. Experience has shown how difficult it is to play some ball games —especially those in which the flight of the ball is rapid—when the light is not fully diffused, as in daylight, but comes from relatively few powerful sources of light mounted considerable distances apart. The main difficulties are evident. It is almost impossible to avoid some degree of glare in the eye of players and spectators from projectors thus arranged, especially as their eyes are adapted to vast surrounding dark areas. The movements of objects thus imperfectly illuminated can hardly be judged with the same precision as in daylight. It is true that, notwithstanding these drawbacks, experience has shown that football, for example, can be played with apparent ease on floodlighted areas. But so long as these limitations exist there will be a tendency to assume that matches played under such abnormal conditions cannot be ranked with those played in the open and by daylight; and in the case of games involving very quick motion of small balls (hockey, lacrosse, tennis, cricket, etc.), the disparity between visibility by natural and artificial light will be still more evident.

What, therefore is the solution? It seems to us conceivable that experience with lawn tennis will be confirmed. In the case of that game serious night play is usually confined to covered courts, not only because the lighting can then be more perfectly contrived, but also because of other drawbacks attending night-play in the open. Once artificial conditions are admitted, there is evidently a great inducement to accept an artificial surface under cover, and escape the vagaries of the climate as well as, in some degree, the Arctic severity of a winter night. (Anyone who has tried to play tennis on a frosty winter evening, and with a keen east wind blowing, will agree that the discomfort is such as to cause deficiencies in lighting to pass into the background). True, it may not be practicable to warm artificially a very large amphitheatre, but at least the temperature in an enclosed space is appreciably higher than in the open, and spectators are sheltered from the winds of winter.

One is inclined to suggest, therefore, that the ultimate solution may be found in a sports-stadium, wholly or partially roofed in, with a skylight admitting natural daylight when available, but designed to permit the addition or substitution of artificial daylight* as desired. In the case of such an interior as this the troublesome contrasts characteristic of outdoor artificial lighting need no longer exist. The overhead lighting can be supplemented by additional illumination derived from other directions. But spotlighting from powerful projectors would no longer be applied. Indirect and diffused lighting from above would be mainly used, built-in units and " architectural lighting " methods would be adopted; the aim being to flood the interior with diffused light from an " artificial sky," so that there is no glare and no harsh shadows. Careful attention would be paid to the reflecting value of surroundings, on which good visibility so largely depends.

Naturally, some experimenting might be necessary to determine the ideal lighting conditions, from the standpoint both of players and spectators. Whilst it is admitted that visibility in full daylight is better than that attained with present methods of floodlighting, it does not follow that daylight conditions should be slavishly imitated; it might be, for example, that after furnishing a moderate general illumination, enabling all surroundings to be easily seen, additional illumination could with advantage be concentrated on the playing area, provided that this is achieved by diffused lighting, free from glare.

* Needless to say, only an approximate visual resemblance to daylight, involving a minimum loss of light by absorption, would be aimed at.

It may, of course, be contended that the construction and lighting of such a "sports-palace" would be too difficult and the cost prohibitive. But this does not seem to be necessarily the case. The initial cost of the lighting would, as always, prove to be a relatively small proportion of the total cost of construction. As regards running costs, it is evident that the expense of furnishing 128 kw. (which suffices to light the White City Stadium), or even double this amount during the period of a football match, would be negligible in comparison with the revenue obtained from spectators. The architectural difficulties involved in roofing-in (or partially roofing-in) so large an area are doubtless formidable, but apparently not insuperable, when one considers the extensive glass covering for, say, St. Pancras Station. A roof high enough to allow the maximum upward travel of the ball could doubtless be provided. It may be noted that the roof need only start from the edge of the stands, and the span would be diminished accordingly.

In compensation for the effort of overcoming these initial difficulties there are certain evident advantages.

An artificial playing surface would, of course, be necessary; some form of rubber composition which should give a firm footing and afford soft falling, and should also have a moderately good reflecting value, might meet the case. There would be constant conditions as regards surface and light. Games played would not be subject to interruption by weather conditions or reduced to a farce by the quagmire under foot.

In all probability the adoption of a standard artificial surface would ultimately lead to a great advance in the skill of players. The rapid improvement of Association football players abroad is ascribed partly to the fact that they play more habitually than we can on firm and dry surfaces. The more rapid game developed by overseas lawn tennis players is admittedly associated with the fact that they play rarely on capricious grass, which in fact tends more and more (except in a few isolated cases where endless pains can be lavished on its upkeep) to become obsolete for play of a high standard. Considerations of wear of an artificial surface, such as could readily be renewed, need not limit the number of events. Several matches could be played on the one day and evening—a number of clubs in the city using the ground, if necessary. Other games besides football—hockey, tennis, lacrosse and pelota—could be staged in addition to athletic and other track events.

One may be told that even if such conditions can be realized it will not be the same as the playing of games in the free and open air and on the carpet provided by nature. By all means let games continue to be played under natural conditions—but let us not deceive ourselves into imagining that they are necessarily productive of skilful play, or of pleasure to the spectator. The carpet provided by nature is not well adapted to stand up to the violence of football. During the recent match between the Arsenal and Chelsea one observed that the greater part of the playing surface consisted of sand. The immense stands which accommodate such masses of spectators surely constitute already a marked departure from nature. The ground is already at the bottom of a well. From many seats in the stands the sky cannot be seen. If one imagines the whole area roofed in, the effect, so far as offence against natural conditions is concerned, would not be very material. It might, however, be appreciated by those who at present frequent uncovered stands, and who are at times exposed to the inclemencies of driving rain and bitter wind. It must be remembered, too, how often important matches are spoiled by rain and mud (in the case of a certain recent fixture in the North of England about *half* of one of the teams had left the field before the end of the game in a state of exhaustion) or even abandoned owing to fog, frost or snow. In the case of amateur games such disappointments may be borne with resignation, but in the case of professional football, which attracts many thousands of spectators, many of whom purchase tickets beforehand and make arrangements long in advance of the match, conditions that would ensure against disappointment of the public are surely worth consideration.

In conclusion, it may be of interest to recall one ball game that has long been played under artificial light and under cover with perfect success—the game of billiards. It is surely no accident that the method of lighting here adopted is free from glare, and designed to produce soft shadows and moderate contrast. Players are well content with a surface that is standard and unaffected by weather, and this circumstance no doubt helps to explain the phenomenal skill attained by the professional in this particular game.

Illumination and Visibility

The paper by Mr. W. J. Jones on "Recent Developments in Electric Lighting," read before the Royal Society of Arts on November 30th, contained some ingenious calculations of the consumption of candles necessary to furnish illuminations usual in the present day. It was estimated, for instance, that the Palace of Westminster would require daily deliveries by a fleet of six three-ton lorries, some half a million candles being consumed per day! The most striking data, however, were those bearing on the relation between illumination and visibility. This has been already illustrated in the familiar report on the influence of illumination on typesetting by hand. But the influence of intensity of light on *speed* of operations has not been studied to the same extent. The author's experiment with letters attached to a pendulum (so that the linear speed of motion varies with the distance from the support) was instructive. As the illumination was increased, so could the letter be distinguished further and further down the length of the pendulum, and—what is particularly striking—the presence of a glaring light at once impairs the speed of perception so that the limiting distance (along the pendulum) at which the letter can be identified is diminished. Vibration, such as is experienced in tubes and buses, also diminishes speed of reading. On the Bakerloo Railway, with an illumination of 2 foot-candles, the 220 words per minute attainable when reading a newspaper in a stationary train was reduced to 140 per minute when the train was running—a diminution of 33 per cent. In a tramcar (top deck), with 2.75 foot-candles the reduction in speed of reading through motion was only 12 per cent; but on the top of an omnibus, with 3 foot-candles, as much as 50 per cent. It is remarked that with the high illuminations of the order of 20 foot-candles furnished on some of the tube railways the effect of vibration is much less marked. This one is quite prepared to believe, but it would be useful to have confirmatory data. There is much yet to be learned in regard to the effect of increased illumination on perception of form, and speed of recognition in letters or other objects—processes which are possibly quite distinct from those dependent on Fechner's Law.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Opal Diffusing Glasses

(Proceedings at the Joint Meeting of the Illuminating Engineering Society and the Society of Glass Technology, held at Caxton Hall, Caxton Street, London, S.W.1, at 6-30 p.m., on Tuesday, December 13th, 1932.)

A JOINT meeting of the Illuminating Engineering Society and the Society of Glass Technology was held at Caxton Hall, Caxton Street, London, S.W.1, on Tuesday, December 13th. Members and friends assembled for light refreshments at 6-30 p.m., and at 7 p.m. the chair was taken by Lieut.-Commander Haydn T. Harrison, M.I.E.E., R.N.V.R. (President).

After the minutes of the last meeting had been taken as read, the Hon. Secretary read out the names of applicants for membership, which were as follows:—

SUSTAINING MEMBERS :—

The British Gas Light Co. Ltd., 2, The Abbey Gardens, Westminster, London, S.W.1.
Representative: Mr. A. J. Mumford.

The City of Leicester Gas Department, Millstone, Leicester.
Representative: Mr. H. Pooley.

CORPORATE MEMBERS :—

Cocksedge, F. M. ......Lighting Engineer, Broxbourne, Heath Drive, Potter's Bar, Middlesex.

Cooper, B. S. ....Physicist, The Research Laboratories of the General Electric Co. Ltd., 13, Park View Road, Ealing, W.5.

Harris, H. D. ....Electrical Engineer, General Electric Co. Ltd., Osram Department, Magnet House, Kingsway, London, W.C.2.

Haslett, Miss C., C.B.E., Director of the Electrical Association for Women, 46, Kensington Court, London, W.8.

Nadaud, C. B. ....Area Sales Engineer, The North Metropolitan Electric Power Supply Co., Highlands, Gordon Avenue, Stanmore.

Ramsden, R. S. ....Hon. Secretary of the Midland Commercial Gas Association and General Manager of Leamington Prior Gas Co., Gas Works, Leamington.

Riant, H. S. ....Reflector and Sign Manufacturer, 73, Canonbury Road, Highbury, London, N.1.

COUNTRY MEMBERS :—

Botley, Chas. ....Engineer and General Manager, Hastings and St. Leonards Gas Co., Gas Offices, Hastings.

Henket, N. H. ....Electrical Engineer, 135, Waldeck, Pyrmontkade 's-Gravenhage, Holland.

Powell, A. R. ....Engineer, Cryselco Ltd., Kempston Works, Bedford.

The names of those announced at the last meeting* of the Society were read again, and these gentlemen were formally declared members of the Society.

The PRESIDENT then called upon Dr. S. ENGLISH to present his paper, entitled "Opal Glass: A Résumé of the Work of the B.S.I. Sub-Committee on Light-Diffusing Glassware." After this introductory contribution, two papers dealing with the more practical side of the work, and entitled "The Theory and Specification of Opal Diffusing Glassware," were presented in abstract by Mr. J. W. RYDE. (Of these two papers Part I was by Mr. J. W. Ryde and Mr. B. S. Cooper; Part II by Mr. J. W. Ryde, Mr. B. S. Cooper and Mr. W. A. R. Stoyle.) The final paper, by Dr. W. M. HAMPTON, was entitled "Some Aspects of the Manufacture of Opal Glass," and, as the title suggests, dealt primarily with problems of production.

The PRESIDENT, in opening the discussion, congratulated the authors of this series of contributions, which together formed an admirable exposition of the subject. He expressed his pleasure in presiding over a joint meeting of the Illuminating Engineering Society and the Society of Glass Technology, devoted to a subject of such great interest to both bodies. He called upon Mr. E. MEIGH (President of the Society of Glass Technology) to open the discussion. Mr. Meigh likewise commented upon the numerous topics of common interest to the two societies, and alluded to some of the manufacturing difficulties that had to be overcome in attaining standardization. Amongst others who spoke were Prof. W. E. S. TURNER (Secretary of the Society of Glass Technology), Mr. L. T. MINCHIN, Mr. H. H. LONG and Mr. F. C. SMITH. After the authors had briefly replied to enquiries, the PRESIDENT proposed a cordial vote of thanks to the authors and the meeting terminated.

* *Illuminating Engineer*, December, 1932, p. 307.

The Illuminating Engineering Society

FORTHCOMING EVENTS.

By kind invitation of the Gas Light & Coke Co., a **Visit** has been arranged to **Watson House,** on **Tuesday, January 10th, 1933.** Members will assemble at 6-30 p.m. An address will be delivered by Mr. C. A. MASTERMAN, and will be followed by a tour of the laboratories and workshops. Those desiring to take part are requested to inform the Hon. Secretary (Mr. J. S. Dow, 32, Victoria Street, London, S.W.1).

The **Annual Dinner** will be held at the **Trocadero Restaurant,** Piccadilly, London, W., on **February 7th** (7 for 7-30 p.m.). Tickets (12s. 6d., exclusive of wine) may now be obtained from the Hon. Secretary.

A paper entitled **"Everyday Photometry by Photo-electric Cells"** will be read by Dr. J. W. T. Walsh, at a meeting to be held in the Lecture Theatre of the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, at 6-30 p.m., on **February 14th.**

Opal Glass: A Résumé of the Work of the B.S.I. Sub-Committee (ELG/3/2) on Light-Diffusing Glass

By S. ENGLISH, D.Sc. (Research Dept., Holophane Ltd.)

(Paper read at the Meeting of the Illuminating Engineering Society, held at Caxton Hall, Caxton Street, London, S.W.1, at 6-30 p.m., on Tuesday, December 13th, 1932.)

AT the Bellagio meeting of the International Illumination Congress in 1927 it was decided to set up Committees in various countries "to establish methods of definition and of testing diffusing materials with a view to secure international agreement on such methods (*a*) for type tests with precise specifications and (*b*) for ordinary routine acceptance tests."

Consequent on this recommendation, the Lighting Fittings Committee ELG.39/3 of the British Engineering Standards Association (now British Standards Institute) in January, 1928, set up a Panel "to draw up definite proposals on the subject of diffusing glassware for international consideration." This Panel (now raised to the dignity of a Sub-Committee) began its work immediately, has kept continuously at work, and is still employed on the problems involved in the comparatively innocent-looking terms of reference. During the whole of its existence, the Sub-Committee has been fortunate in its collaborators, who have placed at its disposal the results of an enormous amount of research work, both of a theoretical and practical nature, and as a result is now on the point of completing a most interesting and important section of the work.

At the commencement of its work the Panel members had only hazy ideas as to the lines on which a specification of the quality and method of testing diffusing glass could be drawn up. In general, such ideas were based on: (*a*) the qualities the illuminating engineer thought he wanted, (*b*) the measuring of these properties in a fairly simple manner, and (*c*) the possibility of relating these qualities to the constitution of the glass itself. The literature on these subjects was inadequate to serve as a basis for deciding any one of these three items, but valuable information was available to the Panel in three British and several foreign publications. A paper by A. P. Trotter[1] on diffused reflection and transmission of light, published in 1919, although an unfinished research, formed an excellent introduction to the practical side of the subject. A Department of Scientific and Industrial Research Report (No. 4) on the "Surface Brightness of Diffusing Glassware for Illumination" and the B.E.S.A. Standard Specification No. 234/1928, dealt practically with one aspect of the problem of opal glass. A paper by G. Schott[2], published in 1925, dealt with the preparation and properties of diffusing glasses, giving transmission data and polar curves showing the distribution of the transmitted light.

The literature dealing with the theory of light diffusion was found to be but slightly more extensive than that mentioned above dealing with its practical aspects. A paper by L. Silberstein[3] discussed the passage of a collimated beam through diffusing media, and did not assume, as others had done, that the diffusion produced by a suspended spherical particle was uniform in character. J. W. Ryde and D. Yates[4] made a combined theoretical and practical attack on the opal-glass side of the subject, and showed the importance of two factors in producing diffusion of light, (*a*) the number of diffusing particles dispersed throughout the glass, and (*b*) the size of these particles. Earlier papers had considered the diffusion of light produced by a diffusing medium as a property of that medium and in no way dependent on the light itself, but it has long been known that in the scattering of light in the air by minute dust particles, the shorter blue rays are much more easily diffused than the longer red rays (Tyndall effect). Ryde and Yates observed and accounted for this same phenomenon in some opal glasses. Experiments showed that certain opal glasses diffused monochromatic green light quite satisfactorily, but failed to diffuse satisfactorily monochromatic red light. This is the reason why some opal glasses permit the filament of an electric lamp to be seen through them as a clear red line. The possibility of using this phenomenon in the form of the ratio of the direct transmission in the red to that in the green as a means of determining and specifying the diffusing power of an opal glass was briefly considered by the Panel, and dropped because of lack of data.

The fundamental factors controlling the diffusion of light on passing through an emulsion such as opal glass are: (1) the particle size, (2) the difference in refractive index between the particles themselves and the clear glass in which they are embedded, and (3) the number of particles contained in a unit volume of glass. The employment of these features as a means of determining and specifying the quality of opal glasses was again hampered by lack of information on vital points.

The possibility of using the polar curves of light distribution of the type given by Trotter as a means of characterising diffusing glasses was considered. This means of approach was strengthened by the communication to the Panel of a report by M. Pirani and H. Schönborn[5] in which they measured the diffusing power of glasses and classified them by determining the ratio of the intensity of the light (from a normally incident collimated beam) emitted along the normal to that emitted at 45° to the normal, using monochromatic light of 550 mμ wavelength. This figure they called the inequality ratio, and classified glasses as follows:—

CLASSIFICATION OF OPAL GLASSES.

Class	% Direct Transmission	Inequality Ratio
A	> 80	> 10,000
B	80—50	10,000—1,000
C	50—20	1,000—100
D	20—5	100—10
E	5—0	10—1
F	0	1

Classes B, C and D were said to be opalescent glasses and classes E and F true opals. The Sub-Committee could see something useful in such a

[1] *Illuminating Engineer,* December, 1919, p. 243.

[2] *Glastech. Ber.,* March, 1925, p. 315.

[3] *Phil. Mag.,* April, 1927, p. 1291.

[4] *Transactions of Society of Glass Technology,* October, 1926, p. 274.

[5] *Glastech. Ges. Bericht.,* May, 1925.

scheme, but realized that it involved certain difficulties and some deficiencies; more particularly there appeared to be no room in this classification for any test of the visibility or otherwise of the filament.

About the same time, the Sub-Committee had communicated to it some details of work done by Mr. J. M. Waldram[6] on the measurement of the reflection, transmission and absorption of opal glasses. Here again was a promising line of attack, but once again more data were necessary before a real start on the work of testing and classifying diffusing glasses could be made. Consequently, in March, 1928, the Panel recommended that the National Physical Laboratory be asked to undertake research in order to provide definite data on which to work, the lines of the research being such as to provide information on (1) the reflection and transmission ratios of various opal glasses, and (2) the possibility of using the reflection/transmission ratio as a criterion of the diffusing properties.

By April, 1929, approval for this research work to be carried out at the N.P.L. had been obtained, and an agreed programme of work had been mapped out. This programme had three main headings: (1) measurements of the efficiencies of opal bowls or spheres of different thicknesses, noting at the same time the visibility or otherwise of the filament, (2) an investigation of the properties of plane samples of the same opal glasses under parallel and diffuse illumination, and (3) determinations of the microstructure and compositions of the glasses.

The first report from the N.P.L. was received in July, 1929, and dealt with tests carried out on a series of opal spheres (each with a small flat to provide the plane pieces required later) of uniform dimensions but varying weights, and all blown from the same melt of glass. Eighteen spheres of 8 ins. diameter, with their neck openings covered by a white card, were tested for (*a*) overall transmission, (*b*) diffuse reflection factor, and (*c*) filament invisibility. The transmission efficiencies ranged from 0.965 for the lightest sphere of $5\frac{1}{2}$ ozs. to 0.815 for a sphere weighing $33\frac{1}{2}$ ozs.; the falling-off in transmission being roughly parallel with the increase in weight (Fig. 1). The diffuse reflection factor varied from

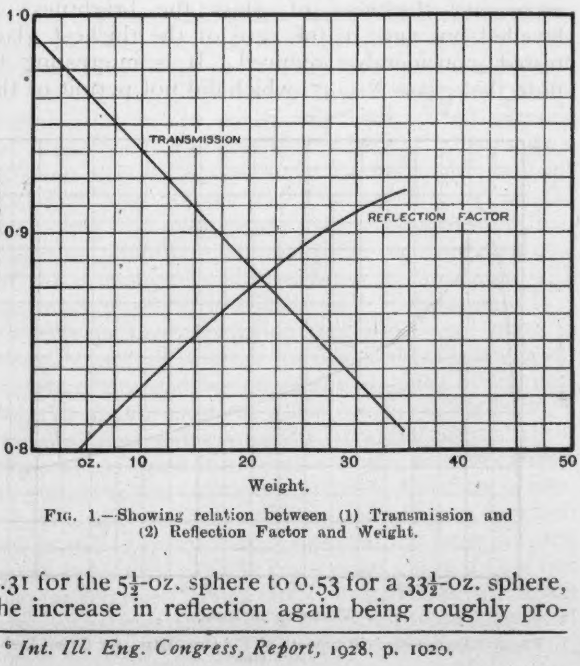


Fig. 1.—Showing relation between (1) Transmission and (2) Reflection Factor and Weight.

0.31 for the $5\frac{1}{2}$-oz. sphere to 0.53 for a $33\frac{1}{2}$-oz. sphere, the increase in reflection again being roughly proportional to the increase in weight. The filament was visible through all spheres up to 20 ozs. in weight; it was just visible through parts of the spheres weighing 25 to 26 ozs., and visible through heavier spheres, although by using a red filter it could just be discerned through places in a 26-oz. sphere.

Unfortunately, this filament visibility was of little use except as a general guide, owing to the variation in thickness of different parts of the spheres.

A second report presented by the N.P.L. in October, 1929, was largely of a theoretical character, and served to determine which characteristics of an opal glass it was necessary to measure in order to fit numerical values into equations connecting the various features and properties of such glasses. For instance, the increase in the diffuse reflection factor with increasing thickness of glass mentioned in the first report was shown to be calculable if certain data were available. Provided the values of ρ and ρ_1 are known (ρ = the diffuse reflection factor of the light-receiving surface of the glass, for light travelling from air to glass, and ρ_1 the same for light travelling from glass to air), it is possible to predict the diffuse reflection factor of any thickness of opal glass by means of two measurements on similar glasses at known thicknesses. Calculated values are in very good agreement with observed values, as

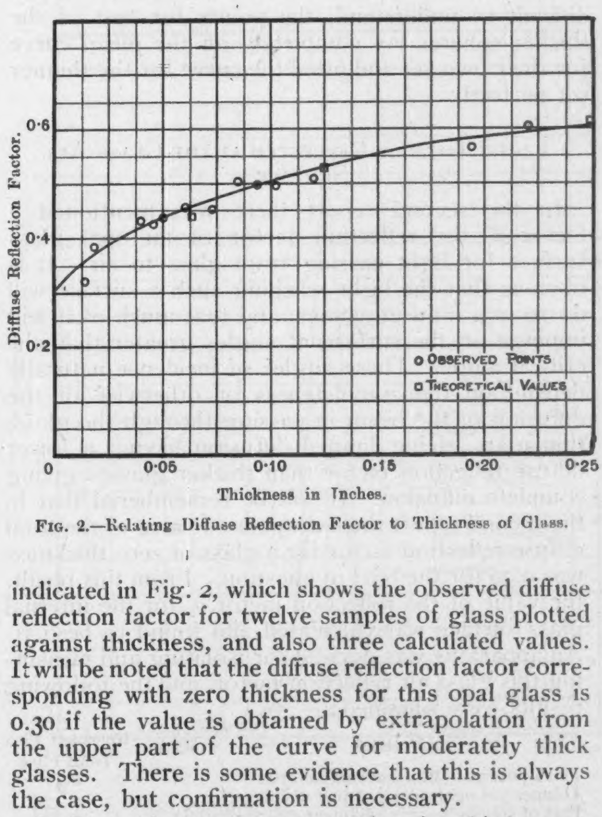


Fig. 2.—Relating Diffuse Reflection Factor to Thickness of Glass.

indicated in Fig. 2, which shows the observed diffuse reflection factor for twelve samples of glass plotted against thickness, and also three calculated values. It will be noted that the diffuse reflection factor corresponding with zero thickness for this opal glass is 0.30 if the value is obtained by extrapolation from the upper part of the curve for moderately thick glasses. There is some evidence that this is always the case, but confirmation is necessary.

In September, 1930, a comprehensive third report was presented by the N.P.L., completing and rounding off several sections of the work.

Efficiency of Spheres at Different Wavelengths.

The work on the transmission efficiencies of opal spheres mentioned in the first report was carried further by determining the transmission efficiencies in different parts of the spectrum using coloured

[6] *Int. Ill. Eng. Congress, Report*, 1928, p. 1020.

eyepiece filters in the photometer. The results showed that in the spheres investigated the efficiency was almost constant for each particular sphere throughout the range of the visible spectrum, and that the constancy was unaffected by thickness except in the case of very thin glasses. As might be expected, these showed a slightly higher transmission in the red than in the blue—a difference of only about 2 per cent. All the glasses showed a slight increase (1 per cent.) in the green, probably due to the very pale green colour of the glass matrix in which the diffusing particles were embedded.

Efficiency of Thick Spheres.

A further set of seventeen spheres was obtained of a similar glass to that used previously, but from a different melt, and thicker in the wall. It was hoped that on measuring the transmission efficiencies of these they would link up with the measurements reported previously on the thinner spheres. This hope was not fulfilled, but instead the thickness-transmission curve for the thicker set, whilst tending to the 100 per cent. intercept for zero thickness, lay wholly below the previous curve. The two curves were straight lines with a common intercept on the efficiency axis, but having different gradients. To those familiar with the difficulties involved in the manufacture of opal glass such a disagreement would not be unexpected, but to make matters really difficult to understand, the points for two of the thicker spheres lay completely off the mean curve for their own set and fitted the curve for the thinner set perfectly.

Light Totally Reflected at the Glass-Air Surface.

In the second report there was mentioned a factor ρ_1, the reflection factor of an opal glass surface for light passing from glass to air. It is obvious that the light reaching such a surface will do so in a diffuse manner, and that much of it will impinge on the surface at angles greater than the critical angle. These angles of incidence naturally depend on the completeness or otherwise of the diffusion of the beam in passing through the glass, thin glass giving limited diffusion having a lower diffuse reflection factor than thicker glasses giving complete diffusion. It will be remembered that in the second report the extrapolated value of the total diffuse reflection factor for a glass of zero thickness was 0.30 for the opal in question. From this result, the value of the reflection factor ρ_1 for the internal glass surface was calculated and found to be 0.31. An apparatus was devised for isolating and measuring this glass-air reflection factor, and the following results were obtained:—

Material	Ratio : $\frac{\text{Reflected Flux}}{\text{Total Flux}}$
Thick pot opal (diffusion complete)	0.47
Thinner pot opal (filament just visible)	0.45
Part of sphere No. 37B (filament clearly visible) ..	0.29
Ground glass	0.20

Sphere No. 37B was the thinnest opal sphere used in these investigations, and was so thin that details of common objects could easily be seen through it. The fact that the observed value of 0.29 agrees so closely with the theoretically calculated value of 0.30 is a good confirmation of the theory advanced in the second report. It is interesting to note that in opal glasses which give good diffusion approximately one-half of the light incident on a glass-air surface is returned by reflection into the body of the glass. Theoretical considerations indicate a rather higher figure, but the difference is not great and is easily accounted for.

Distribution of Transmitted Light.

Complete sets of polar curves showing the distribution of light from a parallel beam at normal incidence transmitted by diffusing materials—as measured by brightness—formed the most important part of this third report. The materials used included pot opals, flashed opals, etched glasses, and milk dilutions. Measurements were made using white, red, green, and blue light, and employing various thicknesses of the glasses. Fig. 3 shows the

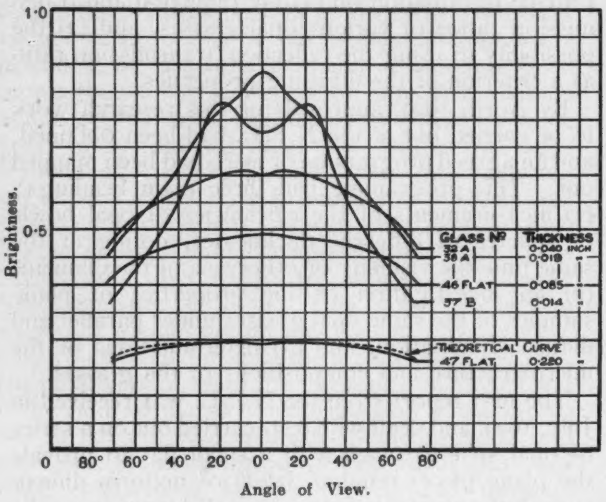


FIG. 3.—Transmitted Brightness of Pot-Opal Glass for White Light.

results obtained for pot opals using white light, the ordinate giving brightness in terms of a perfect diffuser. The brightness at various angles of observation of an ideal diffuser is given in the dotted curve, which is almost horizontal throughout its length. In the thinner glasses the brightness is highest at or near the normal, the brightness falling off rapidly at higher angles of incidence. With increasing thickness of glass the brightness is levelled out and, in the case of the thickest glass tested, considerably reduced. It is interesting to note that glass No. 47, which did not permit of the

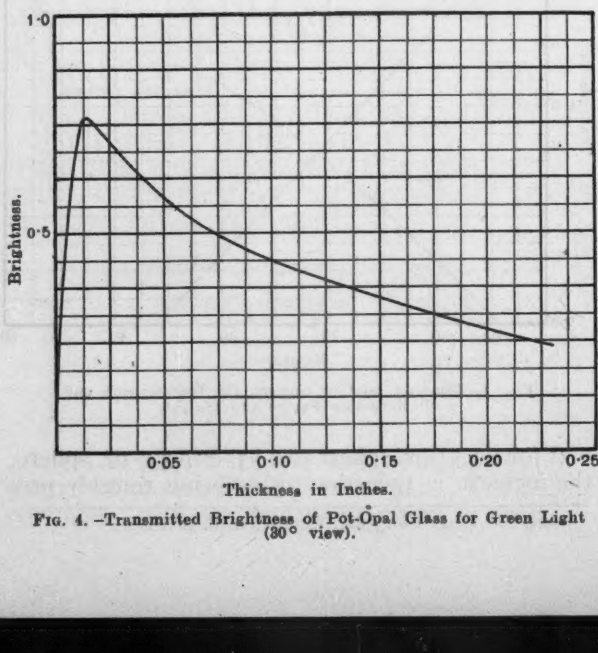


FIG. 4.—Transmitted Brightness of Pot-Opal Glass for Green Light (30° view).

filament being seen clearly through it in any place, gives a brightness curve almost identical with that of an ideal diffuser. Curves for the three monochromatic lights, red, green, and blue, are similar in character. Fig. 4, which is typical, shows the variation of brightness with increasing thickness when observed at an angle of 30° to the direction of the incident light. As would be expected at this angle, with increasing diffusion promoted by increased thickness, the brightness quickly rises and afterwards falls off less rapidly.

The relation between filament visibility and diffusion is further illustrated in Fig. 5, which shows

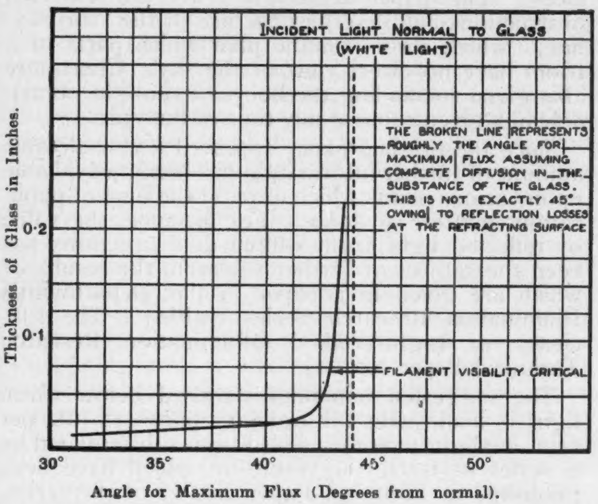


FIG. 5.—Distribution of Light by Pot-Opal Glasses (Incident Light normal to Glass).

the angle at which the maximum flux is scattered, plotted against the thickness of the glass. With increasing thickness of glass this angle increases rapidly up to a point, and then tends asymptotically towards a value of about 44°. The relatively sharp bend in the curve at which the portion indicating practically perfect diffusion begins corresponds with the thickness at which the filament becomes invisible. For this particular glass (No. 47) the filament image disappears for violet light at about 0.06 in., and for red light at about 0.08 in., the critical value lying just on the steeply rising portion of the curve. Thic very interesting and useful relationship is not necessarily true for all glasses, in fact for large-particle diffusing glasses and ground glasses it obviously cannot hold, but for ordinary opal glasses which, when thin, permit the filament to be seen clearly as a reddish-orange line, the conclusion may be drawn that the disappearance of the primary transmitted beam is associated with the attainment of practically perfect diffusion. It is clear from this conclusion that if an opal glass is thick enough to obscure the filament completely, no improvement in diffusion can be obtained by increasing the thickness of the glass; on the other hand, a definite disadvantage, due to increased light absorbtion, would arise from such an increased thickness. It cannot be too strongly emphasized that these conclusions apply only to ordinary opal glasses, in which the particles are of such a size that the light diffused by an individual particle has a polar curve that is not too far removed from a circle. For glasses with much larger particles, the light distribution from individual particles has a very pronounced forward component, and it is quite possible for the direct view of the filament to be obliterated and for the general direction of the light to be little changed. In such cases diffusion is far from perfect, as there is a bright central patch of light surrounded by an area of very much reduced brightness. Increasing the thickness of such glasses would improve the diffusion.

Flashed Opals.

The light distribution from two flashed opal glasses was investigated in exactly the same way as the pot opals. Exactly the same type of results was obtained, and phenomena of the same type were observed, as might have been expected, since the only essential difference from the point of view under consideration is the increased concentration of the diffusing particles in the thin layer of the flashing opal.

Surface Diffusion.

For the sake of comparison, a number of glasses with roughened or rippled surfaces were examined in the same way as the opals. The roughened surfaces were produced by acid-finishing, grinding, and rolling in a pattern during manufacture; and in some cases a combination of two or these means was employed. Brightness curves at different angles of view are given in Fig. 6. As would be expected,

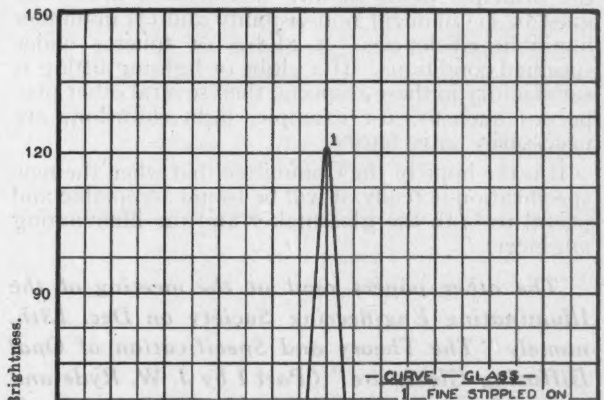


FIG. 6.—Transmitted Brightness of Etched and Patterned Glasses (rough side towards light-source) by White Light.

the brightnesses are of a much higher order than those observed for opal glasses, especially in and near the normal direction. These measurements were made with the roughened surfaces towards the light source. When the glasses were reversed, there was no change in the brightness in the normal direction, but at the wider angles the brightness was slightly reduced, as indicated by the following

results for a plate of glass heavily ground with dry carborundum.

BRIGHTNESS OF GROUND GLASS.

Angle	Ground Side towards Light	Ground Side away from Light
0	11.6	11.7
5	7.76	7.22
10	4.38	3.74
15	1.95	1.65
20	1.01	0.82
30	0.35	0.28
40	0.18	0.16

A summary of these three reports was presented to the Edinburgh meeting of the I.I.C. in September, 1931, by the N.P.L. investigator, Mr. Preston.

From August, 1929, onwards the Committee was exceedingly fortunate in receiving reports from Mr. Ryde and his associate, Mr. Cooper, on work they had been doing in the G.E.C. Laboratories at Wembley on this same problem. In the papers following this, Mr. Ryde is to deal with their particular side of this work. Hence it is unnecessary to say more here than that this work dovetailed perfectly with the work done for the Committee by the N.P.L., and as a result of the data now before it, the Committee feels that it can safely proceed to lay down details of the desired qualities of diffusing glasses (opal glasses in particular) and the methods of testing glasses to determine these properties quantitatively. The Committee's work on this point is not yet finished, but it is safe to say that two of the principal items of any specification drawn up must be (1) filament non-visibility and (2) minimum luminous efficiencies for globes or spheres under specified conditions. If a globe or lighting fitting is satisfactory in these respects, then several other properties such as, for example, light diffusion, are necessarily satisfactory.

It is the hope of the Committee that when the new specification is ready, it will be found acceptable and useful to both the glassmaker and the illuminating engineer.

[The other papers read at the meeting of the Illuminating Engineering Society on Dec. 13th, namely "The Theory and Specification of Opal Diffusing Glassware" (Part I by J. W. Ryde and B. S. Cooper; Part II by J. W. Ryde, B. S. Cooper and W. A. R. Stoyle) and "Some Aspects of the Manufacture of Opal Glass" by W. M. Hampton, will appear in our next issue, together with the account of the discussion.—Ed.]

Fatalities in Streets

According to a recent announcement of the National Safety-First Association, fewer persons were killed in road accidents during the third quarter of 1932, as compared with the corresponding period of 1931. There is hope, therefore, that the increase recorded for the first quarter may be compensated, and that the total for the whole of 1932 may, after all, not be greater than for 1931. It is pointed out, however, that the decrease in fatal accidents recorded is for London, and that for the rest of the country returns show an increase. Furthermore, the number reported injured has increased by 4 per cent.—an increase that occurred mainly in the third quarter of the year. The series of " Safety Weeks " and the intensification of "Safety-First" propaganda during the second quarter of the year had a good effect. But evidently unrelaxed effort and constant vigilance are necessary.

The Penetration of Daylight and Sunlight into Buildings

The first edition having become exhausted, the Department of Scientific and Industrial Research has now issued a second edition of Illumination Research Technical Paper No. 7, on " The Penetration of Daylight and Sunlight into Buildings." This paper has proved of considerable value to architects, officers of health and town-planning authorities since it explains how the adequacy or inadequacy of the natural lighting of a room can be estimated by calculations from architectural drawings. The new edition includes some further explanatory matter both in the original text and as additional appendices. The paper treats the effect of external obstructions and describes the use of the " no sky-line," which shows on the plan which parts of a room have no direct view of the sky. Charts are also given for finding the hours of sunlight obtainable in a given room at any time of the year.

Since the original paper appeared a considerable amount of further information has become available upon various points which were, at the time of publication, matters of doubt. For instance, the value of reflected light from whitened obstructions has been the subject of further research, the results of which are given in a paper in the Department's Illumination Research Series entitled " The Efficiency of Light-Wells " (Illumination Research Technical Paper No. 11).

The suggested minimum standard below which light is inadequate for ordinary purposes (0.2 per cent. daylight factor) has also been substantiated by a series of tests, the results of which have been published in Technical Paper No. 12 of the series, under the title "The Daylight Illumination Required in Offices." In addition, the results obtained in a lengthy series of tests on the reduced transmission of window glass in a typical urban position will be published at an early date.

Glass in the Decorative Scheme

An instructive lecture on the above subject was read before the Incorporated Institute of British Decorators by Mr. M. L. Anderson, on December 13th. The author remarked that glass panes of practically any size required can now be manufactured. He described the process of producing plate-glass by drawing (which is now most usual), as compared with the blowing process formerly exclusively adopted. He explained how glass may be coloured by incorporating the material in the body of the glass. Colour or opal may also be applied as a surface element by " flashing," but this method can only be applied to blown sheet-glass.

Mr. Anderson illustrated the varying effects when light impinges on pot opal, flashed opal, or etched and sandblasted glasses, pointing out how the high transmission value of flashed opal glass renders it useful in illumination. He showed, by experiments, how care must be used in selecting the distance of lamps from any form of diffusing-glass surface, if it is desired that the latter shall appear uniformly bright, without patches.

The concluding portion of the lecture was devoted to such special processes as the deposition of metal on glass. " Silvering " is now done by using nitrate of silver, and there is also an electrical process method of depositing gold which has interesting possibilities. Colours and other materials can be sprayed on to the surface of the glass, and if necessary fired into it. The lecturer concluded by assuring his audience that the glass trade in this country had never been so much alive as at present.

The Artificial Lighting of Libraries

In a paper on the above subject, read at the annual conference of the Library Association last year, Mr. H. Lingard emphasized the obvious but sometimes forgotten fact that light bridges the gap between the written word and the eye, so that without its agency printed books would be useless. Librarians must naturally feel some responsibility when they hear book-reading blamed for faulty eyesight. They appreciate the need for large and legible type in order to overcome this objection—but how often is the influence of poor lighting conditions in causing eyestrain properly understood?

In libraries with adequate window space the natural lighting is usually ample, but this is rarely true of the artificial lighting. Librarians can render an important service to the community in educating others in the right form of lighting for reading purposes. Reading rooms, for example, should be so well lighted that people using them would at once become conscious of the strain of reading by faulty lighting elsewhere, and thus the general standard would in time be raised.

Proceeding, Mr. Lingard pointed out that recent advances, by making artificial light so much cheaper, had removed obstacles to adequate lighting which did exist in the past. He recalled, too, that the eye had developed under outdoor conditions involving distant vision; close processes such as reading inevitably involve strain if the lighting is faulty, and this may affect general health besides vision. In rooms having good access of natural light 100 foot-candles is not unusual, but in artificially lighted interiors it is of rare occurrence to find illuminations beyond 10 foot-candles. There are also qualitative factors which impair the effectiveness of artificial lighting, such as glare and excessive contrast. In this connection Mr. Lingard traced the development of the modern high candle-power electric lamp, and emphasized the necessity for equipping them with modern fittings such as help to eliminate glare, inequality of illumination and dense shadows. He referred also to the effects of indirect and semi-indirect lighting, and pointed out the advantage of modern enclosed diffusing-glass fittings which reduce the brightness to the same order as that of a candle-flame and produce the desirable softness of shadow. Mention was also made of modes of "architectural" lighting suitable for use in libraries, such as built-in fittings involving extensive luminous areas of low brightness.

In conclusion, reference was made to the report on library lighting issued by the joint committee of the Illuminating Engineering Society and the Library Association in 1930. Mr. Lingard quoted details from this report, remarking on the value, for certain purposes, of local lighting as a supplement to general illumination. It must, however, be remembered that whilst certain general rules of lighting can be framed and should, in general, be followed, each particular problem must be judged to some extent on its own merits.

Lectures on Illumination

Some of our readers may recall the very successful course of lectures on illumination arranged at the Polytechnic before the war. The idea is now to be revived. Another course of ten lectures, all by experts on their respective subjects, is to commence on February 8th, and will take place at 6 p.m. on Wednesdays. The course is arranged with the co-operation of the National Illumination Committee and the Illuminating Engineering Society. Whilst the majority of the lectures will take place at the Polytechnic, some of them will be delivered at other centres where there are special facilities for demonstration. It is hoped to arrange visits to the National Physical Laboratory and the G.E.C. Research Laboratories at Wembley.

Those responsible for the lectures have been fortunate in securing Mr. Clifford C. Paterson to deliver the opening address, and, as will be seen from the syllabus below, the other items should all prove of considerable interest.

The fee for the complete course is one guinea. The charge for individual lectures will be 5s. each. We understand that persons furnished with a statement from the Head of their School or Department that they are students will be admitted at half the above fees. Firms who apply for not less than six tickets for their employees can obtain them at half fees.

All enquiries should be addressed to the Director of Education, The Polytechnic, 309, Regent Street, London, W.1.

SYLLABUS.

1. February 8th, 1933.—"Light in the Service of Mankind." By Clifford C. Paterson, O.B.E., M.Inst.C.E., M.I.E.E., Hon. Secretary of the International Commission on Illumination; Vice-chairman of the National Illumination Committee; Past President of the Illuminating Engineering Society.

2. February 15th, 1933.—"Radiation: Light and the Eye." By J. W. T. Walsh, M.A., D.Sc., M.I.E.E., Principal Assistant in charge of the Photometry Division at the National Physical Laboratory, formerly Secretary of the International Commission on Illumination; Past President of the Illuminating Engineering Society.

3. February 22nd, 1933.—"Electric Lamps and Their Applications." By W. J. Jones, M.Sc., A.M.I.E.E., Manager of the Lighting Service Bureau. (*At the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.*)

4. March 1st, 1933.—"Gas Lamps and Their Applications." By F. C. Smith, Assoc. M.Inst. Gas E., of the Gas Light and Coke Co. (*At Watson House, Nine Elms Lane, London, S.W.8.*)

5. March 8th, 1933.—"Daylight: Colour (including Artificial Daylight)." By J. W. T. Walsh, M.A., D.Sc., M.I.E.E.

6. March 15th, 1933.—"Lamp Photometry and Illumination Measurements." By Professor J. T. MacGregor-Morris, Fellow Univ. Coll., Lond., M.I.E.E., University Professor of Electrical Engineering in East London College. (*At East London College, Mile End Road, E.1.*)

7. March 22nd, 1933.—"The Redistribution of Light." By G. H. Wilson, B.Sc., A.M.I.E.E., of the Research Laboratories of the General Electric Co. Ltd.

8. March 29th, 1933.—"Public Lighting." By J. F. Colquhoun, Public Lighting Engineer of the City of Sheffield.

9. April 5th, 1933.—"Lighting for Decoration and Entertainment." By A. B. Read, A.R.C.A.

10. April 12th, 1933.—"Safety, Health and Welfare of Lighting." By D. R. Wilson, C.B.E., M.A., H.M. Chief Inspector of Factories. Followed by a demonstration under the direction of Mr. E. W. Murray. (*At the Home Office Industrial Museum, Horseferry Road, London, S.W.1*).

Literature on Lighting

(Abstracts of recent articles on Illumination and Photometry in the Technical Press)

Abstracts are classified under the following headings: I, Radiation and General Physics; II, Photometry; III, Sources of Light; IV, Lighting Equipment; V, Applications of Light; VI, Miscellaneous. The following, whose initials appear under the items for which they were responsible, have already assisted in the compilation of abstracts: Miss E. S. Barclay-Smith, Mr. W. Barnett, Mr. S. S. Beggs, Mr. F. J. C. Brookes, Mr. H. Buckley, Mr. L. J. Collier, Mr. H. M. Cotterill, Mr. J. S. Dow, Mr. J. Eck, Dr. S. English, Dr. T. H. Harrison, Mr. C. A. Morton, Mr. G. S. Robinson, Mr. J. M. Waldram, Mr. W. C. M. Whittle and Mr. G. H. Wilson. Abstracts cover the month preceding the date of publication. When desired by readers we will gladly endeavour to obtain copies of journals containing any articles abstracted and will supply them at cost.—ED.

I.—RADIATION AND GENERAL PHYSICS.

1. The Ultra-violet Transmission Coefficient of the Earth's Atmosphere. R. S. Rockwood and R. A. Sawyer.

J. Opt. Soc. Am., 22 *pp.*, 513-524, 1932.

Thermocouple measurements made at heights of 10,000 ft., 7,000 ft., 5,750 ft., and 5,000 ft. above sea level near Albuquerque, New Mexico, of the intensity of solar radiation transmitted by a silver filter (3240A) show that in applying the law $I = I_0 a^m$ (where I is the observed intensity of radiation, I_0 the incident intensity, a the transmission constant, and m the mass of air traversed), the magnitude of a, after corrections for water vapour and dust scattering, is independent of the height, and has the value 0.47. This is in agreement with Rayleigh's law for pure molecular scattering, which gives $a = 0.479$. Thus, for clean dry air above 5,500 ft. above sea level, Rayleigh's law is valid. T. H. H.

II.—PHOTOMETRY.

2. Equipment for a College Laboratory: Sphere Photometer. L. S. Foltz.

Elect. J., 29, *No.* 11, *p.* 521, *November*, 1932.

Illustrates a spherical integrator, which is described as follows: "Sixteen similar segments were fabricated of a spherical shell of 60-in. internal diameter. These were cast of aluminium in a commercial foundry and hand-fitted and bolted together. The sphere is separable along the equator, and six legs are supplied so that when separated on a fixed meridian the two resulting parts are self-supporting. It can readily be wheeled from one room to another." J. M. W.

2a. Portable Photometers (Luxometers). Anon.

Lux, V, No. 7, *pp.* 94-95, *September*, 1932.

Descriptions of four patterns of portable photometers used in France are described and illustrated; they comprise those of the Compagnie des Lampes, Niam, Phillips and Blondel-Holophane. The last-named instrument is of a somewhat elaborate pattern and is furnished with colour screens enabling coloured sources to be measured. J. E.

3. Heterochromatic Measurements with the Pulfrich-Photometer. Ernst Mayer.

Phys. Zeits, 33, *pp.* 665-670, 1932.

The Pulfrich-Photometer (Maxwellian view of two separate areas, showing through a single eyepiece two semi-circular photometric fields, between which the line of separation is practically of negligible thickness) (*Pulfrich Zeits f. Instr.*, 45, *p.* 35, 1925) is suitable for heterochromatic measurements, and gives results of the same order as those obtained with other methods. It is recommended specially when the two colours are to be neutralized, and also when the brightness of two colours are to be compared; hence, by means of a single heterochromatic comparison, together with a measurement of the "greyness," two absolute brightnesses are ascertained. This method is stated to be more reliable and simpler than the "step" method. The results are compared with those obtained by different methods for identical objects. T. H. H.

4. Researches in Photo-electric Photometry and Spectrophotometry. P. Fabry.

Revue d'Optique, No. 10, *pp.* 585-598, October, 1932.

The author discusses the precautions that must be taken to obtain high precision in photo-electric photometry, and describes a photo-electric photometer for the accurate measurement of small intensities. The apparatus consists of a vacuum photo-electric cell with a sensitivity of about 20 microamperès per lumen, in series with a very high resistance.

The photo-electric current is determined by measuring by an electrometer method the opposing potential difference that must be applied to the high resistance to reduce the current to zero. Luminous fluxes of the same spectral composition can be compared with an accuracy of the order of one part in a thousand. In conjunction with a double monochromator the apparatus can be used as a spectrophotometer, and the interval of the spectrum utilized does not exceed 5 or 10 millimicrons in width. L. J. C.

5. Photometry with Photo-electric Cells. P. Fleury.

Revue d'Optique, 11, *No.* 10, *pp.* 386-398, *October*, 1932.

Although it is possible to secure greater accuracy with the photo-electric method than with the visual consideration must be given to the want of stability and reliability, in the course of time, of the cell and to the point of incidence of the light on the cell. Methods of reducing the sources of errors, especially for high vacuum cells, are given.

A method of securing precise accuracy with feeble light-sources is also described in full detail. J. E.

6. Precautions Requisite when using Photometers. J. Wetzel.

Lux, V, No. 7, *pp.* 91-93, *September*, 1932.

The author forms the conclusion that with this class of instrument an accuracy limiting the error to 10 per cent. can be obtained. A detailed survey of the calibration and the adjustment of the controls follows, and the author points out the considerable effect on the photometric measurements of comparatively small variations in the pressure or current. The effects of ambient temperature are also discussed, and various details necessary to correct observation and checking of readings are explained. J. E.

7. International Electricity Congress, 1932: (vi) Work of 6th Section (Electric Lighting and Photometry).

R.G.E., 32, *pp.* 616-624, *November 12th*, 1932.

A report on the proceedings of the 6th section (Electric Lighting and Photometry) of the International Electrical Congress. A short account of each of the thirteen papers presented is given. W. C. M. W.

III.—SOURCES OF LIGHT.

8. The Electrodeless Discharge and Monochromatic Light Sources. F. Esclangon.

Revue d'Optique, No. 10, *pp.* 399-404, *October,* 1932.

The paper describes apparatus for the emission of monochromatic radiation by the use of the electrodeless discharge. The apparatus consists of a short-wave oscillator with a power of 300 watts and oscillating at a wavelength of 10 metres. Electrodeless tubes containing gas or a mixture of metallic vapour and rare gases are brilliantly illuminated when they are placed in the interior of a coil of wire forming part of the oscillating circuit. Tubes can be interchanged without in any way altering the electrical or optical arrangements.

With this apparatus the arc spectra of hydrogen, helium, sodium, calcium, zinc, magnesium and thallium have been obtained. The spectrum lines are both sharp and intense. L. J. C.

9. Manufacture of Neon Tubes. L. W. Smith.

Signs, Vol. 5, *No.* 12, *pp.* 577-580, *September,* 1932.

This article outlines the equipment needed for the manufacture of neon tubes, and discusses, in a general manner, the planning of a factory for their manufacture. J. E.

10. Monochromatic Light. F. Esclangon.

Revue d'Optique, 11, *No.* 10, *pp.* 399-404, *October,* 1932.

Describes apparatus for obtaining monochromatic light from gases or metallic vapours contained in tubes without any electrodes by the use of high-frequency waves of 10-metre length with 300 watts energy. The tubes being easily placed in position in the apparatus enables observations to be made without readjustment of the optical system. The arc spectra of hydrogen, helium, sodium, calcium, zinc, magnesium and thallium have been obtained, and their constituent rays readily separated. J. E.

11. A New Lamp for Automobile Headlights. Anon.

Lux, No. 8, *pp.* 117-120, *October,* 1932.

Particulars are given and curves presented showing comparative measurements with other patterns of lamp, of a new double-filament lamp having a moulded bulb, for which more efficient emission, with a better-dispersed and diffused illumination, is claimed. J. E.

12. Development of Electric Lighting in Germany. J. Wetzel.

R.G.E., 32, *pp.* 740-744, *December 3rd,* 1932.

The substance of a pamphlet by Schneider and Seeger, issued by the German Osram-Gesellschaft, is given. M. Wetzel concludes his article by a brief comment on the data given in the table which is included. W. C. M. W.

13. A 3-watt Lamp. G. F. Prideaux.

Light, 2, *No.* 9, *p.* 21, *November,* 1932.

A 3-watt lamp for use on supplies of 115 volts is now available in America. A photograph is given, and various uses are suggested. C. A. M.

IV.—LIGHTING EQUIPMENT.

14. Illustrative Luminous Signs. Prof. Ing. Michele lo Presti.

L'Illuminazione Razionale, V, No. 8-9, *pp.* 173-183, *August-September,* 1932.

A complete illustrated review of methods of luminous publicity. Both stationary and moving signs are discussed. Extended applications of writing signs are studied. The author also examines the use of colour-effects in luminous signs by suitable grading of lamps with glasses of four different colours, "painting by light" being thus substituted for "illustrating by light." J. E.

15. Operating Cinema Projectors. R. H. Cricks.

Kinematograph Weekly, No. 1327, *September 22nd,* 1932.

Dealing particularly with cinema projectors. The author gives information on the many items requiring attention in cinema projector equipment, comprising both low- and high-intensity arc lamps, in order to secure maximum efficiency and steadiness. J. E.

16. Magnetic Arc Control. R. Howard Cricks.

Kinematograph Weekly, Vol. 188, *No.* 1329, *p.* 56, *October 6th,* 1932.

Rectified current from a rotary failed to produce in a high-intensity kinematograph projection arc the luminous flux anticipated from the electrical energy applied. This experience led to an investigation of the forms of "blow magnets" in various makes of projector. A design of magnet was eventually originated that gave with rectified current 5 per cent. more projected light than was obtained with direct current operating under like conditions. J. E.

17. A Flashometer. H. G. Schiller.

Light, 2, *No.* 9, *p.* 24, *November,* 1932.

With very short exposures, the correct synchronization of a photo-flash lamp is of importance. A description, with a photograph, is given of apparatus to measure the time lag of such a lamp. C. A. M.

18. "Ivoryglow." H.G. Schiller.

Light, 2, *No.* 9, *p.* 23, *November,* 1932.

A new indirect lighting unit has been produced in which the reflector is made of a urea-formaldehyde moulding compound. A photograph is given. C. A. M.

19. Modern Electric Street-lighting Equipment. P. J. Robinson.

Electrical Industries, No. 1648, *November 9th,* 1932.

An illustrated article summarizing practical experience and comparative costs. J. E.

20. Concrete Standards for Street Lighting. W. Reilly.

Australian Engineer, Vol. 32, *No.* 195, *pp.* 22/3, 1932.

The questions of general requirements, suitability, strength, durability and life are discussed at length. Manufacture by the spinning and vibratory processes and the special finishes obtainable are described. The author also gives some hints on transport and erection, and replies to questions raised at the meeting of the Illuminating Engineering Society of Australia, before which this paper was read. J. E.

21. Traffic Signals. Anon.

Helios, No. 46, *November 13th,* 1932.

Description of a street lamp combined with traffic-signal gear motor-driven by synchronous motor. The combination of the lighting lamp with the signalling lamp in one lantern ensures economy of energy consumption. The synchronous motor determines the time period, and also permits of a "wave" of signalling to pass along one thoroughfare interlocked with the wave passing the intercepting ones. J. E.

22. Traffic Lantern with Clock Hand. Anon.

Licht u. Lampe, 24, *p.* 373, 1932.

Description of a traffic-control signal, consisting of a lantern on the sides of which are transparent discs divided into red, green, and two yellow sections. An illuminated pointer worked by a small motor moves over each disc. E. S.B-S.

V.—APPLICATIONS OF LIGHT.

23. The Economics of Illumination in Silk and Artificial Silk Mills. N. Goldstern and F. Putnoky.

Licht u. Lampe, 24, *p.* 365, 1932; *and* 25, *p.* 381, 1932.

In continuing and concluding their article on the lighting of silk and artificial silk mills, the authors give statistics showing the increased efficiency of the workers working with the improved system of illumination, and deal finally with current consumption and maintenance costs. E. S. B-S.

24. Trade Follows Light. W. J. Jones.

Electrical Industries, No. 1648, *November 9th*, 1932.

The author states that lighting has gained its position of cardinal importance in industry as a result of three factors: (*a*) it has become cheaper, (*b*) it is regarded as an important decorative and furnishing medium, (*c*) effective apparatus has been developed during recent years for its control. J. E.

25. The "OCELL." Anon.

Lux, V, No. 7, *pp.* 102-105, *September*, 1932.

The abbreviation " OCELL " refers to the electrical house of the Office Central Electrique of Paris. The building is a striking corner structure having a façade of 80 metres, comprising 13 show windows. The exterior illumination requires 80 kw. and the windows 120 kw. An illumination of 250 lux* is available throughout the ordinary rooms of the building, which include a cinema hall, an auditorium and a tea room. J. E.

26. Inadequate Street Lighting Exacts Toll of Lives. R. E. Simpson.

El. World, 100, *pp.* 753-754, *December 3rd*, 1932.

The author discusses the relationship between street lighting and accidents. The increase in utility of street lighting has not kept pace with the increase in the average speed of traffic, and the fact that motorists have been forced to fit more powerful headlamps to enable them to maintain present-day speeds has tended to increase the glare problem, and so further reduce visibility. The author advocates improved street lighting in and about towns, and better headlights for use on other highways. W. C. M. W.

27. Sodium Lamp Lighting. Anon.

Elect., 109, *p.* 741, *December 9th*, 1932.

A description, with details of circuit and spacing particulars, is given of the new sodium street-lighting equipment at Croydon. C. A. M.

28. Costs of Municipal Street Lighting in Chicago in 1931. Anon.

El. World, 100, *pp.* 734-735, *November 26th*, 1932.

A table is given showing a comprehensive analysis of the expenditure on public lighting in Chicago for the year 1931. W. C. M. W.

29. Floodlighting of Streets and Open Spaces. F. Bordoni and E. Carmezzi.

L'Illuminazione Razionale, V, No. 11, *pp.* 242-246, *November*, 1932.

The lighting of streets by means of projectors placed above the cornices of the houses is illustrated and described; also the methods of lighting permanently installed for illuminating public places and the important or historic structures of Rome, which is claimed to be now the best-lighted city. J. E.

* Approximately 25 foot-candles.

30. Lighting the New Underground Stations. Anon.

World Power, 18, *pp*, 354-357, *December*, 1932.

A description is given, with numerous photographs of the architectural lighting equipment at stations on the recent extension of the Piccadilly Railway. C. A. M.

31. Electric Lighting. W. J. Jones.

Elect., 109. *p.* 752, *December 9th*, 1932.

In a review of recent developments in electric-lighting data are given on the effect of vibration on the speed of reading by artificial lighting in various public vehicles in and around London. C. A. M.

32. Probable Applications of Gaseous-tube Lighting. Ward Harrison.

El. World, 100, *pp.* 694-697, *November 19th*, 1932.

This article discusses the possibilities of using various types of gas discharge tubes for purposes of illumination. It is suggested that although people like coloured light-sources, they do not care for coloured illumination. The new sources have great possibilities for decorative lighting and have certain special applications, but the author considers that they are unlikely to come into general use for domestic lighting. W. C. M. W.

33. Illuminating Motor Vehicle Number Plates. Anon.

Lux, No. 8, *pp.* 109-110, *October*, 1932.

The major requirements of the Ordinance issued by the Minister of Public Works on July 16th, 1931, for motor vehicles circulating in France have been overlooked in many instances. These are accordingly repeated, and various methods of complying with them are illustrated and described. J. E.

34. Driving Lights for Automobiles. P. Bossu.

Lux, No. 8, *pp.* 111-115, *October*, 1932.

Various aspects of the problem of obtaining suitable projectors for motor vehicles driven after dark are discussed under the following heads: (1) The quality of the beam projected divided into headings (*a*) the brightness, (*b*) the intensity, (*c*) the homogeniety; (2) the shape of the beam; (3) the disadvantages of concentrated beams; (4) focussing difficulties; (5) fog troubles; (6) rear projectors. J. E.

35. Saving Money with Photo Tube Light Control. C. J. Porter.

Elect. J., 29, *No.* 11, *p.* 506, *November*, 1932.

Describes a photo-electric equipment for the control of the artificial lighting of a factory. The photo-cell is set to turn on the artificial lighting when the daylight falls below 14 foot-candles in a representative position. Considerable savings in lamps and current are reported. J. M. W.

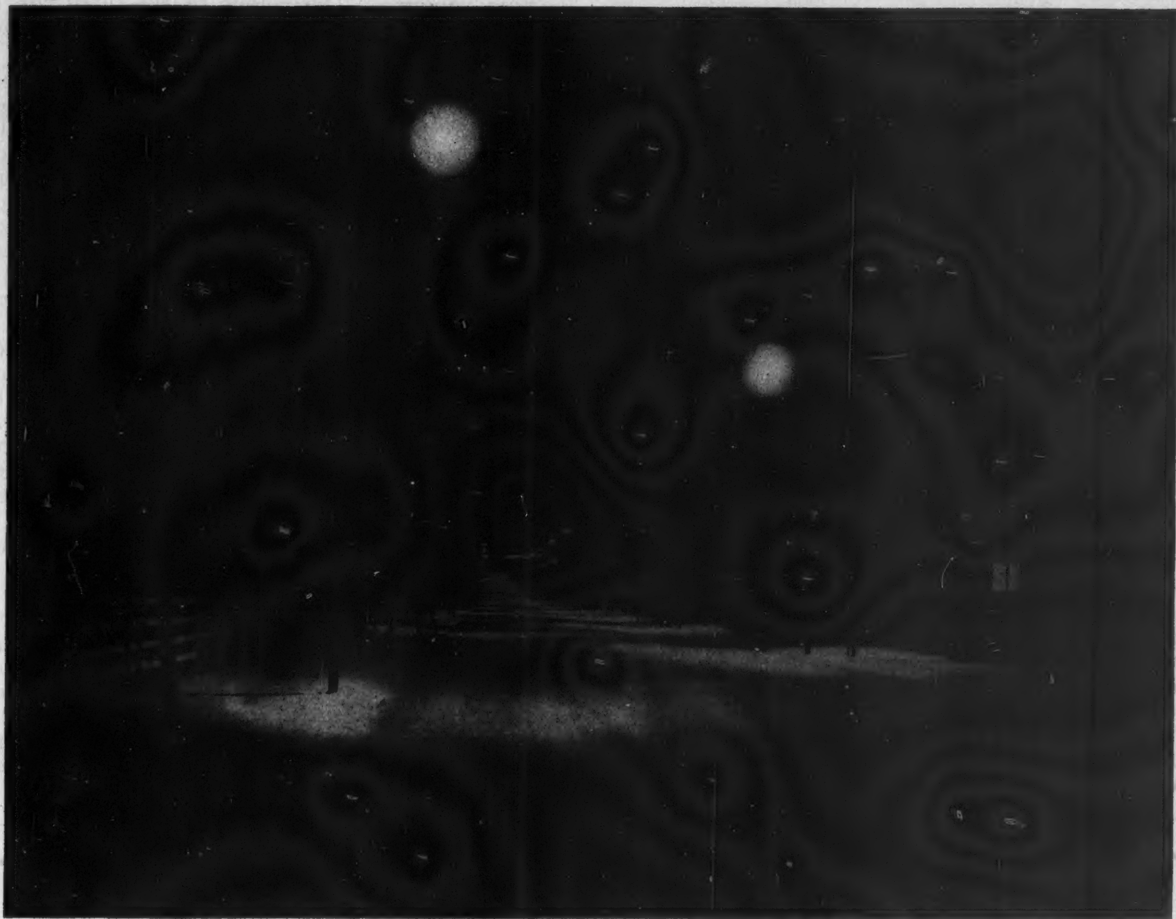
36. An Industrial Application of Photo-cells. D. Hauser.

R.G.E., 32, *pp.* 737-740, *December 3rd*, 1932.

After describing the general properties of photo-cells and the use of valve amplification of photo-cell currents, the author describes a form of photo-electric relay for controlling street-lighting installatins. Tests successfully carried out on the relay by the Public Lighting Department of the Parisian Supply Company are described. W. C. M. W.

Road Lighting with Sodium Lamps

An Interesting Departure at Croydon



A Photograph, taken by artificial light, showing the appearance by night of the Purley Way—Croydon By-pass Road, now illuminated by sodium discharge lamps.

ON December 1st, 1932 a privileged party, including experts and representatives of the Government and local authorities, was allowed to witness the official opening, on the Purley Way—Croydon By-pass (London to Eastbourne) Road, of a highly novel system of lighting—the first installation of public lighting with sodium lamps in this country. The Mayor of Croydon, Alderman William Peet, J.P., in the address of welcome which preceded the switching-on of the lamps, emphasized the importance of safety on the roads, quoting from the recent conclusion of the National Safety-First Association that 98 per cent. of road deaths (which average 17 a day) are avoidable. Safety, he remarked, depends on adequate lighting and on good visibility of objects on the roads, such as this new system rendered possible. Attention was drawn especially to the absence of glare and to the fact that headlights were unnecessary on the road thus lighted. Whilst not regarded as satisfactory for every purpose, the system was efficient for the lighting of arterial roads, where colour-perception was of little importance.

The visitors were then afforded an opportunity of examining the lighting, provision having been made in the meantime for the lamps to attain their full power, for which a certain interval after switching-on is necessary. Visitors were subsequently entertained to dinner at the Aerodrome Hotel. In the course of the proceedings, the Mayor, who presided, took the opportunity of proposing the health of a distinguished visitor, Dr. Philips, of Philips Lamps Ltd., who had come over from Eindhoven in order to attend the opening of this installation of Philips sodium lamps.

The installation, extending over about a mile of roadway, certainly constitutes an enterprising step on the part of the Borough of Croydon and their electrical engineer, Mr. F. N. Rendell Baker, who had made a detailed examination of the system before giving it a trial. The general effect will be understood from the accompanying photograph, in which, however, a somewhat misleading impression is created by the halation round the light-sources. Actually the sources of light, tubular and inclined at an angle, are screened by reflectors. The driver or pedestrian on the roadway therefore does not see the source, but only a small part of the illuminated inside of the reflector, which is of very mild luminosity.

An unsymmetrical staggered arrangement of the light-sources was specially selected with a view to avoidance of glare, direction of traffic and the reflection factor of the road surface. The lamps on either side of the roadway are 165 ft. apart; but those on one side are all set back 65 ft. with regard

to those on the other. Diagrams of illumination indicate a maximum value of 0.8 foot-candles immediately under the lamps and a minimum value of 0.2 foot-candles between them—certainly a high and relatively uniform illumination for an arterial roadway. As the photograph suggests, appreciable bands of brightness are visible on the roadway—a rather unexpected effect, judging from the smooth curves of illumination recorded. One is not, however, unduly conscious of these bands when driving in a motor-car. In these circumstances the brightly lit roadway and the mild luminosity of the lamps on either side of the road, which are substantially free from glare and yet sufficiently bright to mark out the course of the roadway, afford a sense of confidence to drivers. One could appreciate the statement that on a roadway thus lighted headlights are unnecessary. (One was in fact conscious that even the side lights of approaching vehicles seemed too bright, and possibly unnecessary!) The yellow coloration of the light, whilst naturally causing distortion of colours (and producing the familiar "corpse-like" appearance of the countenance associated with sodium light) seemed favourable to definition, objects illuminated appearing—at least to the writer's eye—very sharply defined. This is a familiar effect with monochromatic light, attributed to the chromatic aberration of the eye.

In conclusion, a few remarks on the nature of the lamps may be of interest. The tube is filled with a rare gas, and also contains a small amount of metallic sodium. There are two anodes, and midway between them, an oxide-coated cathode. When the cathode, consisting of an incandescent filament, is made to glow, and the pressure is applied to the anodes, an arc discharge takes place. The initial red colour of this discharge is determined by the rare gas used. The heat developed by the discharge raises the temperature of the glass bulb and the sodium vaporises. From this stage onwards the radiation is mainly due to the luminescence of the sodium vapour. The colour of the discharge is therefore nearly that of the well-known yellow sodium light, and is practically monochromatic.

There are two main types of lamps based on this principle: (*a*) a 100-watt lamp, of which two types intended respectively for A.C. and D.C. circuits are available, and (*b*) a 300-watt type intended for illuminating large areas. The 100-watt (D.C.) lamp, which is intended for illuminating long stretches of roadway, has been used for the present installation. This lamp has a cylindrical bulb, approximately 2½ by 5 ins. The discharge pressure is about 12 volts, the anode current about 5 amperes. The temperature of the bulb at which sufficient sodium vapour is produced lies between 200° C. and 300° C. In order to accelerate the heating of the bulb and to reduce the necessary energy input, the lamp is enclosed in a double-wall vacuum bulb. The mean horizontal candle-power of the lamp is about 500 to 600, and the brightness of the tube about 44 candles per square inch. The total light output lies between 5,000 and 6,000 lumens.

On this system thirty lamps are connected in series. Direct current is afforded by a rectifier, and the filament of the lamps is fed from a miniature transformer incorporated in the cast-iron top of the fitting. In order to prevent the circuit being interrupted in the event of one of the series of lamps failing, over-voltage fuses are connected in parallel to each lamp. In order to keep the total resistance of the circuit constant, if one of the lamps should fail, an ordinary incandescent lamp has been connected in series to every fuse.

Some Notes on the Lighting of the Shakespeare Memorial Theatre

THE Memorial Theatre at Stratford-on-Avon, to which members of the Illuminating Engineering Society paid a visit on October 18th, now serves as a permanent memento of William Shakespeare, whose gifts are acknowledged throughout the world. Yet it is odd to observe that his genius was not widely recognized, at least in Stratford-on-Avon, at the time of his death. Pilgrims, no doubt, had begun to arrive in the seventeenth century, and pilgrimages had become usual and established in the eighteenth. But Mr. A. K. Chesterton has recalled that some twenty years after the death of the poet the Rev. Hon Ward, a local clergyman, wrote in his diary a query as to whether a Mr. Haylin did well "in reckoning dramatick poets which have been famous in England," to omit the name of the Stratford singer. Dugdale, the historian, however, in a book published about 40 years after Shakespeare's death ("Antiquities of Warwickshire"), remarked in connection with Stratford-on-Avon, "it will always be to the glory of this town that it gave birth and sepulture to our great poet, William Shakespeare."

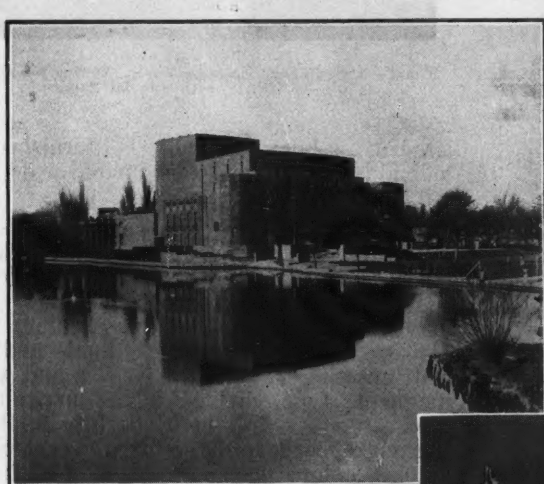


FIG. 1A.—A distant view of the Theatre by day.

In a recent lecture by Mr. F. C. Wellstood* it is recalled that during Shakespeare's lifetime 35 visits of bands of players to Stratford-on-Avon are recorded, the fee given to the players varying from 12d. to 20s. The last such visit during Shakespeare's lifetime was in 1597. In 1602, as a result of the spread of the Puritan movement, it was ordered that there should be no more "plays or interludes," a fine (at first 10s., but afterwards £10) being imposed on any bailiff or alderman who gave licence for such performance. These orders have, apparently, never been revoked to this day! In 1622 the Corporation actually paid the company of players with which Shakespeare was so long associated the sum of 6s. for not playing in the Guildhall!

The jubilee celebrations which David Garrick staged in Stratford on the occasion of the second centenary of the poet's birth, followed by the pageant of characters arranged in 1816, marked the birth of the Festival idea. This, however, was not taken up until 50 years later, when the vision and perseverance of a local business man, Mr. Charles Flower, ultimately led to the building of the first Shakespeare Memorial Theatre on the banks of the Avon.

For many years the Festival movement went on, until 1926, when the theatre was destroyed by fire. Once more, however, a champion was found. Sir Archibald Flower, the present Chairman of Governors of the theatre, set himself the task of restoring the work of his uncle, and the present theatre, opened on April 23rd, 1932, is the result. Two important festivals in the new Building have already been held, the Birthday Festival (April 23rd-May 28th) and the Summer Festival (June 27th-September 10th).

These and other facts are to be found in the souvenir issued in connection with the opening of the theatre. Our immediate purpose is to give some account of the lighting of the theatre, which Mr. Harold Ridge (of Messrs. C. Harold Ridge and F. S. Aldred, the supervising electrical engineers) described on October 18th.

Our first two illustrations show two pleasing external views of the theatre, one as seen by day, the other floodlighted at night. For these we are indebted to Messrs. Philips Lamps Ltd., by whom the floodlighting equipment was furnished. Mention may here be made of a somewhat unusual lighting unit, an umbrella-like reflector on the top of a high pole, that serves to light the courtyard of the theatre.

FIG. 1B.—The same view, but showing the Theatre floodlighted by night.

The structural details and decoration of the interior have been very fully described and illustrated in the *Architectural Review*.† There is much that is interesting, especially the woodwork—many varieties of ornamental wood have been employed. A particularly pleasing example is the door from the main staircase to the restaurant, bearing inlaid representations of the tools and instruments used by the various trades employed on the building.

Much of the lighting comes from concealed sources. A very happy instance is the lighting of the fountain at the foot of the main staircase. The basin is lined with coloured vitreous mosaics, and these receive light from invisible sources mounted round the rim of the basin. The coloured area below the water thus appears brightly illuminated and reflects light upwards on the surrounding brickwork.

* *Stratford-upon-Avon Herald*, October 14th, 1932.

† Vol. LXXI, June, 1932, No. 427.

FIG. 2.—Illustrating the unusual and effective concealed lighting of the Auditorium.

FIG. 3.—A view of the Entrance Foyer, showing the pleasing central fittings with tubular lamps.

In the circle foyer (Fig. 3) again effective use is made of polished wood. The lighting is effected by fittings utilizing tubular diffusing lamps, furnished by Messrs. Siemens Electric Lamps and Supplies, Ltd., to whom we are indebted for this illustration.

The method of lighting the auditorium (entirely indirect) is illustrated in Fig. 2, furnished by the Edison Swan Electric Co. Ltd., whose striplite fittings are here employed. The effect of the illuminated semi-polished diffusing surfaces—glistening luminous lines and bands—although no actual sources are visible, is quite striking, and the installation (like that at the Savoy Theatre) furnishes an instance of how indirect lighting with polished or partly polished surfaces can be applied successfully. The polish gives a degree of sparkle which relieves the monotonous effect apt to be experienced with indirect lighting, and yet any impression of glare is avoided. Here again a great variety of woodwork, such as Indian silver grey-wood contrasting with ebonized mahogany, is employed. A notable feature is the stage curtain in black, crimson, gold, and silver velvet. Portions of the auditorium are lined with pleated fabric for acoustical purposes. Those who were present during Mr. Ridge's address will agree that the acoustic properties of the room are excellent. Every word could be heard with ease. The whole of the decorative lighting in the auditorium can be controlled from the stage switchboard.

The manufacture and installation of the stage-lighting equipment was undertaken by the Strand Electric and Engineering Co., to whom we are indebted for the two final illustrations. In all, 120 switches are provided. All the circuits are brought back to the main control board, where the protective fuses are situated. The dimmers are arranged below the switch panels in six separate banks, corresponding to white, red, blue, amber, and green light; the remaining two are allocated to spot lanterns. Each dimmer is furnished with an individual control and a graduated scale, so that the intensity may be recorded.

The footlights are provided with "sunray" reflectors, and are portable, so that they may be placed in any position on the stage or fore stage as desired. Of the three battens, No. 1 is placed immediately behind the proscenium arch, and consists of twelve 500-watt floods and five 1,000-watt spotting lanterns. Nos. 2 and 3 are of the magazine type, divided into four colour-circuits. Each, together with the footlights, is sub-divided on the stage-board, so that either the centre or the ends of each colour may be used. On each side of the proscenium wall at "perch" level there are three 1,000-watt spots and one 20-amp. special "shutter" arc spotlight.

A special feature of this theatre is the extensive "fore stage," which enables certain scenes to be played in front of the proscenium opening. This has necessitated the provision of appropriate lighting equipment in the auditorium. Immediately over

[*By courtesy of "The Architectural Review.*"

FIG. 4.—A view of the Upper Flights of the Staircase, at the foot of which the Illuminated Fountain is situated.


Cheap lamps -
a complete
failure

the proscenium arch there is a chamber equipped with twelve apertures, through which four-colour lighting can be projected down on to the upper portion of the fore stage, a supplementary circuit being provided to illuminate the tableau curtains. There are also eight 1,000-watt spot lanterns concealed in the structure of the circle front, and four additional spot lanterns are mounted behind a concealed opening in the main ceiling through which light can be directed on to the whole of the fore stage and acting area. Amongst other special equipment may be mentioned stage plugs for portable stage-lighting apparatus, provided on either side of the stage and in each fly gallery; and apparatus enabling the stage manager to give both audible and visual signals to all necessary points on the stage for "cues."

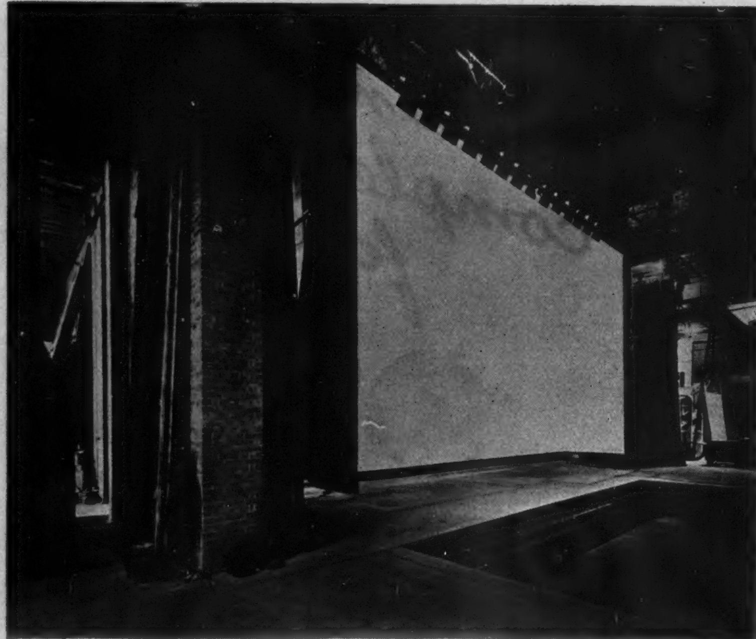


FIG. 5.—A view of the Stage, showing Cyclorama and Lighting Units; on the right a glimpse of the remarkable travelling stage is seen.

The lighting of the cyclorama is unique in that the apparatus is installed at the top edges, and so arranged that the maximum intensity is obtained at the base, thus providing a horizon effect. The lighting is arranged on a three-colour system (red, blue, and green). The switchboard operator, by the aid of dimmers, can obtain any desired shade of colour. (The dimmers for this section are specially wound to the formula of Messrs. Ridge & Aldred.) A series of 10-watt lamps fitted behind minute holes in the plaster fabric furnish a constellation of thirty stars. These may be caused to "twinkle" by means of a motor-driven resistance carried on the cyclorama. Two cloud-lanterns are also provided.

The control of the decorative lighting in the auditorium is effected on the stage switchboard by means of a push-button, which operates a specially designed motor-driven dimmer installed in a small room at

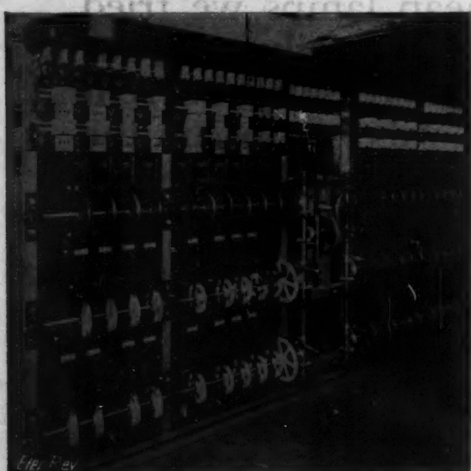


FIG. 6.—A view of the Switchboard and Dimmer Regulator.

the back of the circle. To this dimmer the whole of the wiring of the lighting is brought. The lights can be dimmed in three stages, starting at the back of the auditorium, each stage taking three seconds, a total period of ten seconds being required for the whole operation. The effect of the lights "dying away" towards the stage is quite striking, and members of the audience are thus unconsciously led to concentrate their attention on the proscenium opening.

Sheffield Illumination Society

About 80 members and friends of the Sheffield Illumination Society spent an enjoyable evening at Stephenson's Restaurant, Sheffield, on December 2nd, at their eighth annual social. Mr. J. F. Colquhoun, the Lighting Engineer, and Hon. President of the Society, presided. Councillor Mrs. A. E. Longden, who is a member of the Lighting Committee, was also present. Mr. Colquhoun said that the Society had had a most successful year, and their members were being maintained, despite the fact that the staff of the Lighting Department was, unfortunately, decreasing to some slight extent. Councillor Mrs. Longden, in the course of her remarks, spoke of the great improvement that had been made in the public lighting of Sheffield during the past eight years.

An excellent concert and whist drive followed, the prizes being distributed by Mrs. J. F. Colquhoun.

At the annual general meeting, held in the Corporation Lighting Department on December 5th, the Hon. Secretary reported a membership of 104, and referred to a small technical library that had recently been inaugurated.

The officers for 1933 are as follows: Hon. President and Founder, Mr. J. F. Colquhoun; Immediate Past President, Mr. A. C. Burrell; President, Mr. J. Oates; Vice-President, Mr. E. Selwood; Hon. Secretary, Mr. E. Marrison; Assistant Hon. Secretary, Mr. M. G. Lockwood; Hon. Treasurer, Mr. R. Parker; Social Secretary, Mr. N. Schofield; Auditor, Mr. J. Whitehead; Committee, Messrs. G. Sayer, J. Scorah, A. Watchorn, E. Grayson, A. Butterill, C. Midson, A. L. Williams, W. G. Brookfield and A. Hustler.

The syllabus of the Society for 1933 includes lectures by Mr. J. P. Lamb on "A Visit to the United States," by Mr. H. C. Collett on "Gas Works Practice," and by Mr. J. E. Tyler on "Sheffield a Century Ago." There is also a discussion by members on "Street-lighting Topics," and numerous visits and outings have been arranged—the annual outing being this year to Lincoln. Instruction and entertainment are thus agreeably blended.

Modern Lighting at Ciro's Club

(*Communicated.*)

FIG. 1.—The Restaurant, showing lighted frieze of figures in bas-relief.

[By courtesy of "The Architectural Review."

FIG. 2.—The Cocktail Bar in the Entrance Hall.

WHEN the redecoration of Ciro's Club was undertaken a few months ago, it was realized that for the restaurant something outstandingly novel was essential. Mr. Michael Rosenauer, the architect, set himself to obtain this result, and his decoration scheme was designed to depend largely on lighting effects for its success, and he engaged Allom Brothers Ltd. to carry out the installation and to manufacture the fittings.

One of the features of the scheme is a lighted frieze of figures in bas-relief, as shown in Fig. 1. For this he commissioned Mr. Maurice Lambert to carry out the plaster reliefs.

The main lighting of the room is given by ten circular drum fittings, each containing a 75-watt Allom reflector, so designed that an even diffusion is given over the lighting surfaces of the fitting. Glass pendant fittings under the balcony and opal glass and metal brackets above supply the required intensity of light in those parts of the room not sufficiently influenced by the drums.

These three sets of fittings are each controlled by dimmers and can be reduced in power, thus enhancing the colour-lighting of the frieze. The figures on the latter are lighted by a device which enables the lamps to be completely concealed from view from above. Reflectors are used to distribute the light over the figures and a three-colour lighting scheme is introduced. Red and blue effects are

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A very pleasing effect is also to be seen in the lower photograph. The base of the fountain (which is, in fact, of plaster) gives the impression of being translucent—an effect obtained by the introduction of a patent internal lighting device. It is such devices as this that make the Allom System of Lighting of special interest to illuminating engineers who are always on the look out for new and ingenious devices.

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obtained by dimmer control, which include also the band recess, and are infinitely reproduced in the mirrors which line the walls.

The entire current consumption of the white lighting scheme is only 3½ kilowatts, which is remarkably low for this type of room. The six dimmers in use in this room control a number of different variations of the colour schemes and the intensity of the lighting. Special attention has been given to colouring of the fittings so that soft lighting is obtained although the main sources of light are direct.

Fig. 2 shows the cocktail bar in the entrance hall. Two 150-watt reflectors diffuse light through a false glass ceiling, and additional light is thrown on to the bottle shelves at the back.

In the American bar, Fig. 3, three mirror-lined columns carry reflectors in projected caps, which give indirect lighting from silver walls and ceiling. Pink and amber colours are introduced into this effect to give particular softness and warmth.

The whole effect of the installation is one of restfulness. A low current consumption was an important consideration in the scheme, but it has in no way impaired its success.

[*By courtesy of "The Architectural Review."*
FIG. 3.—The American Bar, Ciro's Club.

Football by Floodlight

Those who were present at the football match, under Northern Union rules, played by artificial light at the White City Stadium, on December 14th, must have been struck by the enterprise of Brig.-General Critchley. This is probably the first occasion on which floodlighting on a scale comparable with that adopted in Continental and American cities has been provided. The arrangements at the White City Stadium were completed under the direction of Mr. W. T. E. Blunden, head of the Lighting Department of Messrs. Philips Lamps Ltd., within the short period of 4½ weeks.

Briefly, the method illustrated below consists in the use of four steel towers, each 115 ft. high, and bearing 32 narrow-beam 1,000-watt projectors, which are located at the four corners of the ground. There are thus in all 128 kw. employed. It is stated that each projector furnishes a beam-candle-power of 250,000 and has an effective range of 80-1,000 ft. An illumination in a vertical plane of 14 foot-candles and in a horizontal plane of about 5 foot-candles was recorded.

So much for the lighting arrangements. Impressions of the effect seem to vary somewhat, but on the whole the experiment must be pronounced a success. There was, as is not unusual at this time of the year, a considerable amount of mist about, so that the conditions were not entirely favourable. Nevertheless, in the writer's experience the flight of the white football could almost always be traced with ease, and, in general, the movements of players could be seen perfectly. It was naturally less easy to identify players and their numbers than by full daylight, and occasionally there were failures to catch the ball that might have been due to cross-glare from projectors or imperfect visibility of the ball. But critics may be reminded that even in full daylight mishandling is far from unknown, and that it is frequently very difficult, even in daylight, to observe the details of play in distant parts of a football field.

Admittedly, the conditions are not yet ideal. One fancied, for instance, that fuller diffusion of light and less evident shadows might have improved visibility, and one was also conscious that the lights on the towers, in spite of their height, did occasion some degree of glare. But one formed the impression that football, at any rate, can be successfully played by artificial light, and that the idea has come to stay.

FIG. 1.—A General View of the Stadium, floodlighted.

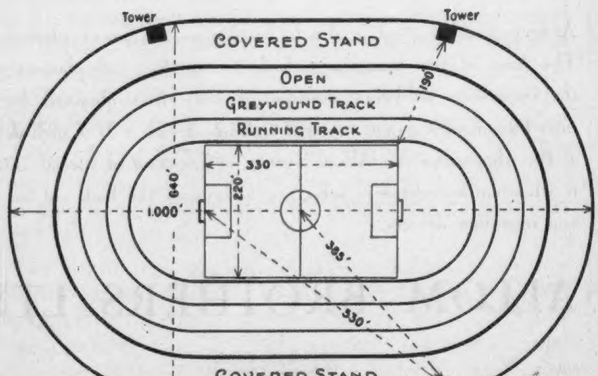
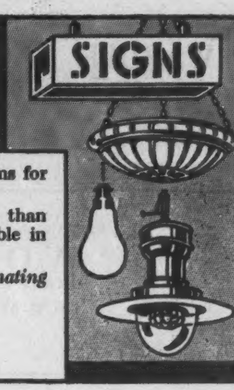


FIG. 2.—Showing dimensions of Playing Area and positions of Pylons carrying lights.

(Since the above was written it has been announced that, with the sanction of the Football Association, a game between two Soccer teams has also been arranged to take place at the White City Stadium. This game will take place on January 4th between two teams composed of representatives of leading professional clubs.)

·WHERE TO BUY·
A DIRECTORY OF LIGHTING EQUIPMENT



We invite applications for spaces in this new section of the journal. Particulars of terms for each space (approx. 1 inch deep and 3¼ inches wide) are given below.

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Ediswan Secures Important G.P.O. Contract

We are informed that the Edison Swan Electric Co. Ltd. has secured a large contract for the supply of telephone switchboard lamps to the General Post Office—undoubtedly a good send-off for the New Year.

The New Osram Low Volt Long Series Traction Lamp

We have been asked to make a small correction in the account of the above lamp, which, it will be recalled, was shown by Mr. S. J. Patmore at the Opening Meeting of the Illuminating Engineering Society, on October 11th.* This, although a low-volt lamp, is not "a 10-volt," as suggested in the description.

* *The Illuminating Engineer*, December, 1932, p. 322.

The Lighting of Sydney Harbour Bridge and City Railway

We have received a letter from Mr. A. P. Turnbull, who is associated with the Department of Transport, New South Wales, in regard to our note on the above installations.*

The work attracted much attention in Europe. In the case of descriptive matter relating to developments so far away, it is perhaps not to be wondered at that there should be occasional misunderstandings or inaccuracies. Mr. Turnbull points out an apparent error in our description of the lighting above the escalator platform of Wynward Station. This was, in fact, carried out in ordinary mill-rolled glass, sandblasted on the inner or smooth face. On the other hand, the "shadowless" illumination of the Wynward concourse *was* carried out entirely in Holophane glass, after exhaustive trials with other varieties. (It was also intended to use Holophane prismatic sheet glass in the large pedestal lanterns for the bridge approaches, but unluckily this was not procurable in time for the opening date.) The illumination of the train indicators at Wynward Station is furnished by the platform lamps, but train stops are indicated by small neon gas lamps opposite each station name.

Mr. Turnbull's chief complaint, however, is our use of the word "spectacular" in referring to the lighting of the bridge. In such work he evidently, and quite rightly, considers fitness for the purpose is the chief consideration; the only item that might be considered spectacular is the floodlighting of the granite pylons flanking the shore ends of the main span—which, though installed permanently, will be reserved for special occasions, such as the King's birthday.

In describing the effect as "spectacular" we did not mean to imply that it was "theatrical," but we think that anyone who glances at the night view of Sydney Harbour Bridge, reproduced on p. 227 of our September (1932) issue, will agree that the effect is striking to a degree. So far as we can judge, from the views sent us by Mr. Turnbull, the lighting of the bridge is of a dignified and impressive character. But if, in addition, some effort were made to reveal by artificial light the fine proportions of this bridge—one of the wonders of the world—it would seem to us natural and not spectacular in any unworthy sense.

We may conclude by commending to the notice of those interested in these installations the excellent description contributed by Mr. A. P. Turnbull to the Illuminating Engineering Society of Australia (*The Australian Engineer*, May 7th, 1932, pp. 11-15) and an article by Mr. W. H. Myers in *The Electrical Engineer and Merchandiser* (May 16th, 1932, pp. 39-45).

Holophane "At Homes"

An enterprising departure during the past year has been the series of "At Homes" arranged in the Holophane theatre and laboratories. At the last of the series, held on November 29th, some pleasing examples of the possibilities of colour-lighting were furnished, the blending of the lighting with dancing displays being skilfully contrived by Mr. R. Gillespie Williams. A lecture illustrating specialized applications of Holophane products followed, after which visitors were entertained to tea.

* *The Illuminating Engineer*, September, 1932, pp. 226-227.

Northampton Polytechnic Building Extension

An encouraging sign is the increasing demand for evening instruction classes, as illustrated by the experiences of the Northampton Polytechnic. During the past eight sessions there has been a continuous advance, so that 1931-32 attendances exceeded those nine years earlier by at least 100 per cent. So long ago as 1926 it was evident that accommodation was becoming inadequate, and a scheme of extension was initiated.

The extension has now been completed and occupies a part of a site facing the main Polytechnic building. It is designed to accommodate the chemistry, watch and clock making, furriery, lens workshop, and automobile laboratories, as well as various lecture rooms and classrooms for general use. The total floor area is approximately 28,000 square feet.

A pleasing feature is the entrance hall, with woodwork in English oak. This is furnished with attractive electric light fittings designed by Mr. A. C. Jolley, head of the Electrical Engineering Department. One is glad to observe, also, that in the various workshops and laboratories in the new building up-to-date lighting has been installed. The new buildings were formally opened on December 2nd.

The Physical Society

TWENTY-THIRD ANNUAL EXHIBITION.

This familiar annual event, which is to take place at the Imperial College of Science and Technology (South Kensington) during January 3rd-5th, is announced under the auspices of the Physical Society, with which the Optical Society has now been amalgamated. Optics and the optical industry are, however, quite as fully represented as in the past.

As usual, the section on research contains numerous items of interest in connection with illumination and photometry. The General Electric Co. Ltd. exhibits an improved Schlieren apparatus, rendering visible the motion of air currents. This device, which has proved specially useful in examining movements of hot air around electric lamps and fittings, is based on the difference in the refractive index of air at different temperatures and pressures. Other exhibits by the same firm include a new precision visual photometer, the now familiar "Ray-Path" apparatus, and amplifiers for photo-electric photometers. The British Thomson-Houston Co. Ltd. illustrates the control of lighting by means of photo-electric cells, which have also been used to record continuously variations in daylight. A new flashing road-signal device is also being shown by this firm. Finally, mention should be made of an exhibit in the Research Section by Dr. W. S. Stiles and Mr. B. H. Crawford, illustrating the variation in luminous efficiency of rays entering the pupil at different points (a ray entering the eye near the periphery of the extended pupil being apparently only about one-third as efficient as the axial ray).

Amongst the trade exhibits are several photometers, such as the latest form of "luxometer," the Weston photo-electric illumination photometer, and others. Other devices include new types of photo-electric cells with maximum sensitiveness respectively in the visible green and infra-red, applications of photo-electric cells to record smoke and other suspensions of solid particles in air, gases or liquids, and an apparatus permitting the examinaton of substances under ultra-violet light derived from daylight.

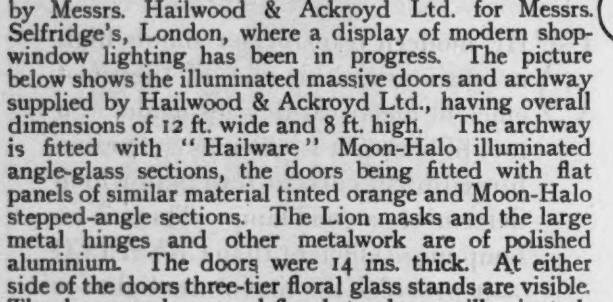
TRADE NOTES & ANNOUNCEMENTS

The Burlington Adjustable Table Standard

The "Burlington" adjustable table lamp, here illustrated, figures in a list recently issued by the Typerlite Company, and embodies features resembling those of the "Grosvenor," "Auction," and other portable lighting units supplied by this firm. It has, however, a special knuckle joint, fitted immediately above the base, which enables the user to bring the stem down to any desired position, e.g., from the top of a piano, bureau or shelf. The base of the fitting is heavily weighted, so that there is no fear of the lamp falling. The flexible arm, characteristic of the whole series of units, can be readily moved into the necessary position. Like the "Grosvenor" fitting, the "Burlington" is all-metal, finished black and chromium, with a hand-painted black-and-white translucent shade.

An Illuminated Archway

We recently referred to the installations carried out by Messrs. Hailwood & Ackroyd Ltd. for Messrs. Selfridge's, London, where a display of modern shop-window lighting has been in progress. The picture below shows the illuminated massive doors and archway supplied by Hailwood & Ackroyd Ltd., having overall dimensions of 12 ft. wide and 8 ft. high. The archway is fitted with "Hailware" Moon-Halo illuminated angle-glass sections, the doors being fitted with flat panels of similar material tinted orange and Moon-Halo stepped-angle sections. The Lion masks and the large metal hinges and other metalwork are of polished aluminium. The doors were 14 ins. thick. At either side of the doors three-tier floral glass stands are visible. The doors, archway and floral stands were illuminated, and the effect was most pleasing and attractive.



Linolite Strip Reflectors

A substantial diminution in the price of Linolite Strip Reflectors, namely, 1s. off single lamp lengths and 6d. per lamp length off 2- and 3-lamp lengths, has recently been announced by Messrs. A. W. Beuttell Ltd. The new prices, which came into operation on December 9th, 1932, are embodied in the latest leaflet, which gives particulars of reflectors and lamps, bronzed case Linolite, skeleton strip and weather-proof facia reflector.

Wolf Electric Mine Lamps

There has been much discussion on desirable features in miners' lamps—a somewhat loosely used term to cover several varieties. A recent list issued by the Wolf Safety Lamp Co. (Wm. Maurice) Ltd., of Sheffield, shows that this firm is supplying quite a number of distinct types, all, however, using the latest type of alkaline mine lamp accumulator. The Wolf alkaline lamp, it is stated, has been in use for 20 years, and it has to its credit a number of distinctive achievements, being the first to embody quite a number of now familiar improvements. In particular, it is claimed to be the first high candle-power miners' electric lamp.

One type of lamp here listed (No. 950/E) weighs 10 lbs., lasts for 10-12 hours, and is stated to yield 6 candle-power without any reflector—a great improvement on figures customary in the past.

The miners' lamp, which permits illumination in all directions and is fitted with a diffusing globe, is distinct from the "inspection lamp." in which the bulb is surrounded by a reflector, and thus emits a concentrated beam. A somewhat modified form of inspection lamp (equipped with changing red, green, and white screens) makes an excellent shunters' signalling lamp.

The company has also a system of coal-face lighting, and supplies one particularly serviceable form of portable lamp for general purposes—the turbo-electric lamp operated by compressed air.

Industrial Floodlighting in Scotland

An interesting recent floodlighting installation is afforded by the works of the Clyde Valley Electrical Power Co., now illuminated by means of G.E.C. projectors equipped with 1,000-watt Osram lamps. The installation was contrived on economical lines, only twelve floods being used; six of these are mounted along the main frontage, and three are used to illuminate the portion of the building on the right, which lies back from the main building. Special illumination is also furnished to bring out the name "Clyde Valley" on the small building in the front, which is a pumping station, and to merge this into the main ensemble.

School Lighting in Sweden

An illustrated booklet issued by the Svenska Foreningen for Ljuskultur, the enterprising organization in Stockholm that has recently been responsible for numerous special lighting demonstrations, deals with school lighting. Introductory articles discuss the subject from the standpoint of the medical man and the schoolmaster. In subsequent pages the principles of good lighting are briefly stated, and there are pictures and diagrams contrasting unsatisfactory obsolete lighting conditions with those found in modern installations. Examples of both direct and semi-indirect lighting are presented. The illumination at working level seems to be in the neighbourhood of 5 foot-candles, and thus corresponds with the value recommended by the Committee of the Illuminating Engineering Society. Effective illustrations emphasizing the importance of avoiding troublesome shadows from hand or head are included. The final section of the booklet deals with the lighting of assembly rooms, workshops, drawing offices, gymnasiums, etc.

The Lamp You Sell

We have received from the E.L.M.A. Lighting Service Bureau, 15, Savoy Street, and 2, Savoy Hill, London, W.C.2, an enterprising booklet issued under the above title and dealing with the sale of electric lamps. In the introduction the inadvisability of handling inferior lamps is emphasized. A comparison of the cost of lamps and the cost of energy bears this out—in fact, it is contended that in the example cited, even if the cheap lamp were given away it would still be uneconomical to use it! The manufacture and standardization of lamps produced by the six named British manufacturers are described. It is stated that continuous research work carried out by the six manufacturing firms named amounts to more than £100,000 annually, and the work of the Lighting Service Bureau maintained by them is described. A final diagram shows how, during the period 1914-1932, a fall in the cost of living has been accompanied by diminished cost of the 60-watt lamp, which to-day gives an average of 25 per cent. more light throughout its life than in 1921. Moreover, the bulbs do not blacken as in the past, and the filaments are very much more robust.

This is an excellently got-up booklet. Copies may be obtained on application to the Lighting Service Bureau.

"The Reflector"

The December number of *The Reflector*, issued by Benjamin Electric Ltd., contains a seasonable article dealing with shoplighting, of which some good illustrations are given. There is also a description of the lighting of the Service Depot of the Austin Motor Co. at Northfield, Birmingham, which is stated to be by far the largest in Europe, and which is illuminated by 250 Benjamin Glassteel diffusing units. Another contribution deals with the circumstances under which the inverse square law does not apply (i.e., when the dimensions of the source of light are large in comparison with its distance from the point where the illumination is measured). When an installation is sufficiently large and the series of units mounted at regular intervals sufficiently numerous, an increase in mounting height of 2 ft. to 3 ft. will often have no measurable influence on the illumination available on the working plane. A final section deals with types of motor-car headlights supplied by Benjamin Electric Ltd.

G.V.D. Illuminators

In our last issue some particulars of G.V.D. Illuminators exhibited at the opening meeting of the Illuminating Engineering Society were illustrated and described.* These were pendant units and pedestal floor standards.

In a recent visit to the showrooms at Aldwych House we were shown by Mr. G. V. Downer some developments of the system that are even more interesting—notable in its application to artificial skylights and "pillar" units. The artificial skylight is itself composed of ordinary decorative diffusing glass of low absorption. Above this is a shallow curved diffusely reflecting surface at one extremity of which a single focussing lighting unit is mounted so as to cast a horizontal beam. The reflecting surface is thus illuminated to approximately uniform brightness, and the skylight-glass itself likewise appears to be at even brightness, notwithstanding the fact that the illumination is derived from a single source—in this case a single 250-watt lamp. This lamp sufficed to provide about 10 foot-candles throughout the room, which was nearly 200 square feet in area. Another advantage of the system is that the distance between the diffusing glass and the partition or floor above can be quite small, in this case little more than a foot.

The other new device is of a decorative character, and consists of a pillar, hexagonal or octagonal in section, each face of which is composed of decorative diffusing glass. In this device the light is derived entirely from a concentrating unit at one extremity of the pillar. The diffusing surface of special shape is again brought into play, and is developed on a lengthy cone. The concave surface of the cone extends from top to bottom of the pillar terminating in the apex, which is just below the lamp, mounted in its concentrating reflector at one extremity, and its base is situated at the end remote from the light-source. Here again also good uniformity of the brightness of the luminous pillar can be attained.

Some Recent Lists

Amongst recently received lists and catalogues we may mention a pleasing four-page leaflet illustrating the application of colour for various lighting installations, issued by Holophane Ltd. Typical lighting units suitable for restaurants, ballrooms, theatres, cinemas, etc., are illustrated in colour.

Messrs. Siemens Electric Lamps and Supplies Ltd. are responsible for a catalogue (No. 516) featuring enclosed lighting units, which are now listed in a great variety of shapes.

"G.E.C. Hotel Lighting," issued by the General Electric Co. Ltd., is another attractive booklet, containing pictures of recent installations. Most of these relate to interior lighting, but there are several effective outdoor views, depicting the floodlighting of hotels, miniature golf courses and gardens.

Contracts Closed

The following contracts are announced:—

SIEMENS ELECTRIC LAMPS AND SUPPLIES LTD.:—

Union Castle Mail Steamship Co. Ltd.; for six months' supply of Siemens vacuum and gas-filled lamps.

HOLOPHANE LTD.:—

Holophane Ripple-Lite Units have been installed for the lighting of the *Midland Counties Mutual Benefit Society* at Dudley; also in the new *George Hotel* at Wolverhampton.

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* *The Illuminating Engineer*, December, 1932, p. 326.

SPECIAL INFORMATION.

THE ILLUMINATING ENGINEER (the Journal of GOOD LIGHTING) was founded in January, 1908, and has thus been in existence for twenty-five years.

SINCE the year 1909, when the Illuminating Engineering Society was founded in London, it has been the official organ of the Society.

IT is *the only journal in this country exclusively devoted to Lighting by all Illuminants.*

IT receives the assistance of contributors who are leading experts on illumination in this country and abroad. Foreign Notes and News will be a speciality, and correspondents have been appointed in all the chief cities of the world.

THE Journal contains *first-hand and authoritative information on all aspects of lighting;* it has also been improved and extended by the inclusion of a *Popular and Trade Section* containing special articles of interest to contractors, gas and electric supply companies, Government Departments and members of the Public.

DISCUSSIONS before the Illuminating Engineering Society which are reproduced in this Journal are participated in alike by experts on illumination and *users of light*, whose co-operation is specially invited.

Good Lighting is of interest to everyone. The Journal is read by engineers, architects, medical men, factory inspectors, managers of factories, educational authorities, public lighting authorities, and large users of light of all kinds.

BESIDES being issued to all members of the Illuminating Engineering Society, the Journal has an independent circulation amongst people interested in lighting in all parts of the world. The new and extended form of the Journal should result in a continual and rapid increase in circulation.

Every reader of THE ILLUMINATING ENGINEER, the Journal of GOOD LIGHTING, *is interested in illumination, and is a possible purchaser of lamps and lighting appliances. Gas and Electricity Supply Undertakings likewise benefit by the movement for Better Lighting, with which the Journal is associated, and which stimulates the demand for all illuminants.*

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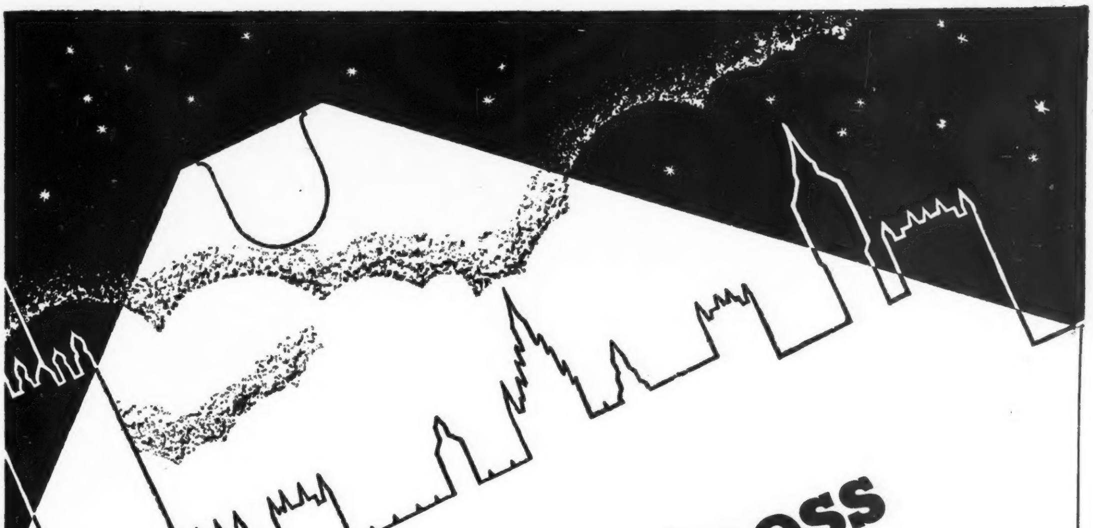

Printed by Taylor Garnett Evans & Co. Ltd., Manchester and London.

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